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THE WORLDS COLUMBIAN EXPOSITION—A GERMAN ARTIST'S JOURNEY FROM NEW YORK TO CHICAGO.

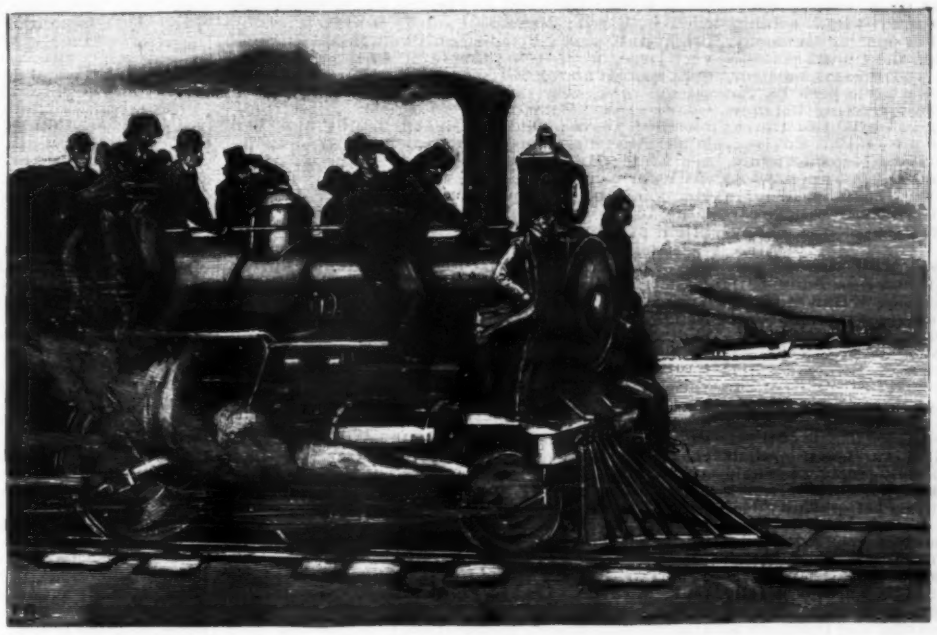
MR. C. LIMMER is one of the special artists of our esteemed cotemporary the *Illustrirte Zeitung*, of Leipzig, and in a recent number of that journal he gives a short letter descriptive of some of his first experiences *en route* to Chicago, and also some fine sketches, which we here reproduce. He says:

"On American railways the system of special guardians for the guests of the road is unknown. In Germany a bell is always rung or passengers are called at the proper time, and, especially in Saxony, the polite employe of the road inquires with fatherly care whether one wishes to travel first, second, third or fourth class, with or without smoking or ladies' coupe. Strict orders forbid opening of a coupe door, and many other means of protection are observed, while here it is 'help yourself. The train will start in so many minutes; come at the right time and take a seat in the right car.' For us Germans this is extremely trying at first, but one soon becomes accustomed to it.

"All first-class trains on the Michigan Central R.R. are provided with so-called palace cars, which, in point of elegance and comfort, leave nothing to be desired. The roomy saloon of the parlor or drawing room car is fitted up with the most elegant Smyrna carpets, silk curtains, and upholstered chairs, and while chatting pleasantly the passenger enjoys a view of the flying landscape through large windows. Folding tables are provided which add much to the comfort of the traveler when he wishes to read, write, or eat a luncheon. In communication with this saloon are the smoking room, the toilet rooms, an office in which there is a typewriter ready for use; and the dining car is connected with the train by a covered passageway. The dinners served here are excellent. Finally, there is the sleeper, with clean and comfortable beds.

"The road on which I am traveling from New York to the 'Queen of the Lakes,' Chicago, runs along the Hudson. This river is the richest in legends, most celebrated in history, and the most beautiful of any in the New World. Thousands of vessels of every description—tow boats, whole chains of freight boats, brigs, three-masters, yachts, and, above all, those world-renowned floating palaces, the gigantic Hudson River steamers—pass up and down the river from New York to Albany, a distance of 144 miles, lending to the stream an ever-changing life. At the last-named city the road crosses the river, and, entering the Mohawk Valley (see the illustration), passes over a charming country and through the thriving cities of Schenectady, Amsterdam, Little Falls, Ilion, Utica, Rome, Syracuse, Rochester. From Little Falls I went with my traveling companions on an excursion to Dolgeville, which we reached in the evening, and where we were received with music by the German athletic and singing societies of the place, that owes its name and its success to a native of Leipzig, Alfred Dolge, who has accomplished wonders here in a short time. After being hospitably entertained here, we continued our journey toward Buffalo, and to-morrow I shall be admiring Niagara Falls, and the day after I shall reach my destination, Chicago. Farewell for to-day.

"Your travel-worn special artist, C. LIMMER."



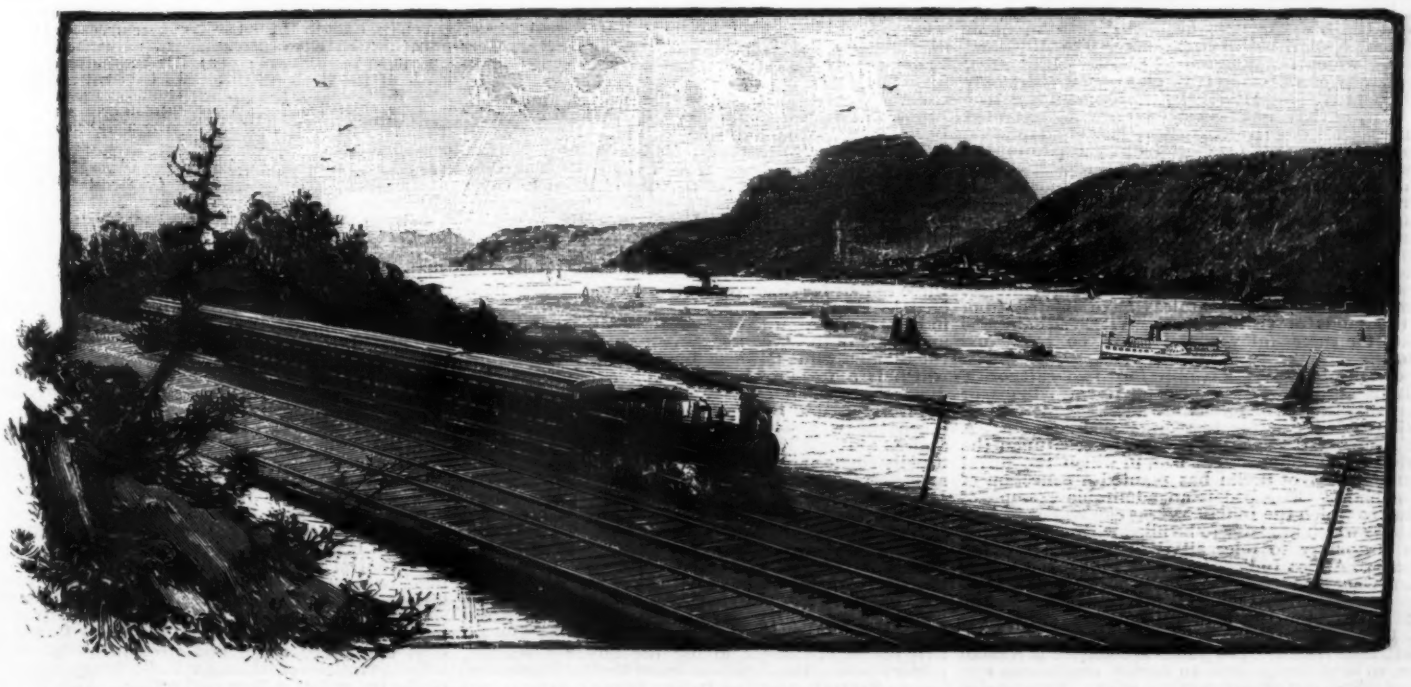
GOING TO CHICAGO.

AN ENGLISHMAN'S VIEW OF CHICAGO AND ITS EXHIBITION.

JUST a month—a fortnight prior to, and a couple of weeks after, the opening on the first of May—is my experience, up to date, of what the Chicago people delight to call the "World's Fair." Fair, or no fair, in all this time we have only had two fair days. Snow, sleet, thunderstorms, and torrents of rain have visited us, either successively or all together, while under foot the mud has been deeper than any ordinary European could consider possible. Even now, on this, the 13th day of May, outside the trees are bare, and there is not a green leaf to be seen on any of them; while all mankind wear overcoats, and fairly shiver as the cold wind blows keenly from across the lake.

Chicago, as most people probably know by this time, is some seven miles from its show, and even now the ways of covering that distance are far from perfect. If you go from the middle of the city by cable car at a cost of 5 cents (2½d.) it takes an hour, and the elevated railway, for the same sum, does the distance in 40 minutes. The Illinois Lake Shore line charges 20 cents, and takes half an hour, while the lake steamers (wretched old tubs) make the trip in about an hour. The cost is "a quarter" (1s. ½d.) The quickest way is by what are locally known (at least in the British section) as the cattle trucks. These are a series of through trains, consisting of carriages as rough as are the fourth class on the German lines. The ride costs 10 cents, and the ground is got over in exactly a quarter of an hour. The trip by water is the pleasantest, and in the present old steamers, certainly the most adventurous. Chicago, seen from the lake, looks not unlike Birkenhead as we see the latter when coming into Liverpool by sea.

It was so emphasized to me that I should find Chicago so greatly improved during the interval of twelve years that has elapsed since last I visited it, that I freely confess great disappointment in failing to discover much improvement. Given that it is infinitely larger, the least that is said of it the better. There are some immense buildings thrown in, in a haphazard



THE WORLD'S COLUMBIAN EXPOSITION—THE TWENTY HOUR TRAIN FROM NEW YORK TO CHICAGO—VIEW ON THE HUDSON RIVER.

sort of way, among others of mean character. The roads are awful, and save in a comparatively few streets, the pavements are wretchedly bad. These "sidewalks" within half a mile of the city's busiest center are often nothing but planks, more or less rotten and deficient. Some of the hotels are most superbly fitted up, the beautiful marbles of the United States—among the loveliest marbles I ever saw—being used with excellent effect. There appear to be no churches of any architectural pretensions. Most of them, in artistic merit, are below the average Dissenting chapel in England.

My first impressions of the Exhibition are still maintained. The place is altogether too big, and will assuredly be—financially—a gigantic failure. The charge to exhibitors and their assistants of 3 dols. (12s. 6d.) apiece for their entrance tickets is very unpopular. There are something like 35,000 of these, so that about £15,000 is made by the transaction. True it is that the promise is thrown out that two-thirds of the money will be returned at the close of the Exhibition if the passes are handed in again, but this assurance is generally taken with an unusually large grain of salt, as this is not a country for returning anything in the shape of that "almighty dollar" it loves so well. Although the grounds are now in a fairly good state, and there is generally little mud, the exhibition is still in a very incomplete condition. Here, in the Manufactures building in which I write, some countries have only just commenced to erect their show cases. Great Britain was almost the only country whose exhibits were, practically, all ready for the opening ceremony. Of the most important countries, the United States is the most behindhand, and at the present moment, Tiffany, of New York, who holds what is, perhaps, the best site in the place, is only just erecting his show cases. It is, perhaps, due to a great extent to the excellent arrangements of our commission that England, in the matter of punctuality, has cut so good a figure, and Mr. Bowdidge and Mr. Arthur Dinney, upon whose shoulders much of the practical work has fallen, deserve every credit for the manner in which they have carried out difficult duties without the least friction anywhere.

The number of workmen who were killed or seriously hurt during the erection of this immense building (it looks as if its *motif* was the Agricultural Hall at Islington) is appalling. Things are all right now, and accidents are few. The British section is fortunate in having a capital St. John's Ambulance Association exhibit under the superintendence of Sergeant-Major Dring, V.M.T.C., whese practical illustrations of the various methods of treating injured people are a source of constant interest to visitors.

"Visitors!" There have been precious few of them, comparatively speaking, up till now. The thousands of thousands that Chicago fondly pictured would flock to her Fair from all parts of the world have not put in appearance yet. Everything is frightfully dear and overdone.

The town and works of Pullman are some seven miles from the Exhibition, and lie in an opposite direction to the city. Every one who comes here should visit them—indeed, I am not quite sure they are not as fully interesting as is the Exhibition itself. The day we had there was a most instructive one, and the more so because in Mr. Richard Adams, formerly of Sheffield, but now on the Pullman staff, we had such an able, genial guide. HARRY HEMS.

P.S.—The most frightful thing in the entire Exhibition—perhaps in the whole world—is the gigantic gilded statue of Liberty. It stands at one end of a lagoon, and faces an equally wretched figure mounted in what is known here as the electrical car. For grotesque renderings of classical subjects, these two figures, situated as they are in the most prominent part of the grounds—to use an Americanism—take the cake.—*H. H. in The Building News, London.*

[FROM GARDEN AND FOREST.]

THE COLUMBIAN EXPOSITION.

AZALEAS.

DURING the third and fourth weeks of May, azaleas have excited more attention from visitors than any other portions of the floricultural exhibits. The number of varieties shown, both indoors and in the open, is very large, and the flames of color have quite eclipsed the less showy plants. Azaleas have never won wide popularity in America, especially the Ghent varieties, which are adapted to outdoor cultivation. This scarcity of azaleas in lawn planting is commonly attributed to the severity of our climate, and it is true that many of the imported varieties are not adapted to our circumstances; but this very lack of adaptation is, no doubt, due to the almost indiscriminate importations of foreign kinds. Among all the azaleas now upon exhibition at Jackson Park only one lot is American grown. This is from the Parsons' nurseries on Long Island. If greater attention were given to the propagation of hardy kinds by our own nurserymen, the time could not be far distant when sufficient varieties for all purposes should be obtained. If one may judge from the almost unanimous surprise and interest which the beds of Ghent azaleas have elicited from the thousands of visitors at the World's Fair, the market for successful varieties could be easily extended.

The azalea exhibits fall readily into two categories, the Indian or evergreen kinds and the deciduous or Ghent varieties. The former are adapted only for cultivation indoors or for temporary bedding out. A good temporary display is now to be seen upon the wooded island, filling a large bed, in which the Royal Botanic Garden of Berlin has planted a collection of Alpine plants. This bed is an admirable example of the use to which the Indian azaleas can be put in outside beds which are later to be filled with other plants. It is customary to refer all these Indian, or house azaleas, to Azalea Indica, but it is probable that A. amœna sometimes occurs among them. There are two large competitive exhibits of Indian azaleas in the north wing of the Horticultural building. These are from Otto Olberg, Dresden, and Ch. Vuylsteke, Loochristi, near Ghent. The plants are massed in a small space, so that they present an almost continuous surface of mixed and almost dazzling color. The one distinguishing feature of the collections is the great variety in color, markings, size and texture of the flowers. The plants are uniformly well grown, although they are not superior in this respect to specimens which may be seen in any good American collection. An idea of the great variety of the display can be had from the fact that Mr. Olberg shows one hundred and seventy-eight and Mr. Vuylsteke seventy-eight named kinds. It is impossible, save on the simple score of the number of varieties shown, to pronounce upon the relative merits of these two great collections. Mr. Ludwig Schiller, who has charge of the German horticultural exhibits, considers the following to be the most meritorious of Mr. Olberg's varieties: Ernst Papenberg; Generalpostmeister von Stephan, very brilliant amaranth red; Kaiser Wilhelm, double pink; Alba fimbriata plena, clear double white; Alpen Rose, double rose; Anna Klein, double white, striped with red; Apollon (of Cryssen), white, with red stripes; Baronne de Vriere, white, red striped; Bernhard Andreæ alba, double white; Bignoniæflora plena, double rose; Ceres, white, rose striped; Deutsche Perle, large double white; Doctor Wilhelm Neubert, rose; Eborina plena, double white; Empereur du Bresil, double, delicate rose, with white border; Frau Hermann Seidel, double white; Frau Oberburgermeister Cassian, white, striped red; Helene Thelemann, double rose; Hermosa, double rose; Kronprinzess Victoria, double rose.

Among the varieties shown by Mr. Vuylsteke, I was most attracted by La Reine des Blancs, a very large single white; Etendard de Flandre, single white, penciled with red; Madame Paul de Schryven, double bright rose, pink; Memoir Louis van Houtte, double, very large, bright rose; Comte de Chambord, blush, dark spotted above; Grossherzog Ludwig von Hesser, salmon pink, very double; Bernhard Andreæ alba; Comtesse de Beaufort, large single, bright pink, blotched above; Duc de Nassau, bright rose, very large; Arlequin, double, pink splashed with deep red and white; Mrs. Turner, delicate blush, spotted above, single or semi-double; Othello, brick red, double; Hermoine, bright pink, double; Theodor Reimers, large and double, pink purple; Doctor Mezger, very bright pink rose, double.

Among the Ghent azaleas, the largest collection is one of 116 varieties, by the Boskoop Holland Nursery Association, represented by C. H. Joosten, of New York. This occupies a conspicuous position on the island, and as several varieties are freely duplicated it makes a most remarkable blaze of color, which is conspicuous from many points beyond the lagoon. The term Ghent should properly be restricted to those varieties which bloom with the appearance of the leaves. The varieties which bloom before the leaves appear are not true Ghent azaleas, and they remain a shorter time in bloom and give a narrower range of color than the genuine Ghent varieties. The colors are very striking, however, because of the absence of leaves. These early varieties are the ones more properly referred to Azalea mollis. In this account, however, all the hardy deciduous azaleas are discussed together. There are very many excellent varieties in the collection, but those which strike one most forcibly at this writing, the last of May, are Pallas, light copper pink, with dull orange above; Rosea rotundifolia; Wilhelm III., copper yellow, with markings of red; Cardoniana, bright salmon pink; Nancy Waterer, orange yellow; Professor Koster, bright dark pink; Ebenezer Pycke, rick pink salmon; Madame Caroline Legrelles d'Hanis, light pink, with slight tint of salmon; W. E. Gumbleton, bright dark yellow; Comte de Kerchove.

Other collections of Ghent azaleas in the open ground are those of Ch. Vuylsteke, Belgium, fifteen varieties; about a dozen varieties from J. C. Vaughan, Chicago; a small collection from Ellwanger & Barry; thirteen varieties from Moser, of Versailles, near the Women's building, and the American-grown plants from Parsons, comprising twenty-five varieties. These last are not yet in flower, but they promise well.

The most unique, and in many respects the most valuable exhibit, of deciduous azaleas is a display of seedlings made by Anthony Waterer, of Knap Hill, near London. These plants are seedlings of Azalea mollis, A. Sinensis and A. occidentalis, and they are remarkable for the great variety and brilliancy of color and free habit of growth. It is expected that these azaleas will prove hardy in the Northern States. Mention must also be made of a good collection of Ghent azaleas from Mr. Vuylsteke, which were forced into bloom in the Horticultural building early in May. These were very effective. The varieties which were used for this purpose are Comte de Gomer, Madame Caroline Legrelles d'Hanis, Milton, Comte Papadopli, Freya, Ch. Francois Lupis, Ernest Bach, Hora, Aida, Baron Edmond de Rothschild, Phebe, Virgile, Velasquez, Praxiteie, Byron, W. E. Gumbleton, Norma, Murillo, Titun, Alphonse Lavallee, Mr. Desbois, Consul Pecher, Ribera, Charles Kekul and Phidias. Good standard Ghents are shown by Mr. Vuylsteke, both indoors and out, and by Moser, near the Women's building.

The Japanese show some interesting azaleas. The most striking ones are large and free-growing bushes, three to four feet high, of dull pink-red, single flowered Azalea Indica. These are used along the walks in the Japanese garden in the Horticultural building, and again in the Japanese garden on the island. On the island a white-flowered bushy azalea is growing, which is a free-growing form of A. Indica. Very diminutive, small-leaved and small-flowered azaleas are freely used in the garden indoors for borders in much the way in which we might use box. These azaleas are said to be A. Indica. Their flowers are usually single and self-colored. One variety attracts attention from its very small greenish white flowers. It is called Mitsusomekuruma. About twenty named kinds of these diminutive azaleas are shown. Several varieties of the Ghent type are also on exhibition. There are two exceedingly curious forms, in which the corolla is reduced to five separate and long strap-shaped divisions. In one instance, of the mollis type, the petals are red and spotted and the stamens are wanting. In another, of the Indica type, the petals are dull pink-red, and the long red filaments are entirly barren of anthers, giving the flower a strange, spidery look. The Japanese know the deciduous azaleas as Tsutsuji, and the Indian type as Satsuki and Kirishima, the former name denoting a late and the latter an early class. L. H. BAILEY.

[FROM THE GARDENERS' MAGAZINE.]

HORTICULTURE AT THE COLUMBIAN EXPOSITION.

THE world has been vastly improved through the agency of exhibitions in the past, and as a matter of course it follows that much good will result from the magnificent display of the earth's products which was opened to mankind at Chicago on the first day of May. In the welding of hearts and nations there is no more potential influence than that diffused by proceedings of this nature, and there has never been so perfect a representation of arts and industries as that which will engage universal attention for the next few months. A more propitious time for the affair could not well have been chosen. The people of the more important countries are in greater harmony with each other than at any period of history, thus insuring such kindly cooperation as befits the celebration of the quadri-centennial anniversary of the discovery of America by a man who was at once the greatest of navigators and among the most eminent of the benefactors of the human race.

So generous, indeed, and ample has been the response to the call issued for exhibits that the authorities have been compelled to resort to selection, accepting only representative material of the character best calculated to show progress and development. Anxious as were the people of the United States to fully accommodate everybody, they found soon after the applications for space began to pour in that it would be quite impossible to do so were the undertaking to be brought to the desired point within any reasonable measure of time. Glancing at the amount of space and capital set apart for the work of preparation, one cannot but feel amazed at this restriction, as it would then appear to be an insurmountable difficulty to collect sufficient worthy material to fill the place.

The exhibition grounds embrace an area of 1,037 acres, while the various buildings cover more than 5,000,000 square feet, and it has been estimated that the expenses of the exhibition, independent of the appropriations made by foreign governments and the various States of this country, will not be much short of £3,600,000. This is far in excess of the amount expended on any former exhibition. The great London Exhibition of 1851, that for which Sir Joseph Paxton designed the Crystal Palace, cost about £292,000; that of Paris, in 1855, £1,000,000; that of London, in 1862, £460,000; that of Paris, in 1867, £800,000; that of Vienna, in 1873, £2,000,000; that of Philadelphia, in 1876, £1,600,000; and that of Paris, in 1889, including the Eiffel Tower, £1,300,000.

Jackson Park, the site of the exhibition, is admirably situated about six miles from the center of the city, and is in a general way of oblong form. It is washed by the broad waters of Lake Michigan on one of its longitudinal sides, and there are dispersed about the grounds numerous lagoons and inlets, by means of which an extensive water frontage has been secured to each of the most important buildings. This arrangement lends dignity to the flat and otherwise tame surroundings, the entire vicinage having been of a low, swampy character previous to the excavations and dredgings which resulted in raising the higher portions of the ground, and in better defining the depressed spaces. The utility of water in similar works has never been so fully demonstrated as in the present instance, and it appears safe to predict that the example will be freely copied in the future. The distribution of the buildings and general planning of the grounds were entrusted to Mr. Frederick Law Olmsted, an eminent landscape gardener of Boston, and needless to say, the work has been performed in a perfectly artistic manner. In this Mr. Olmsted was well seconded by his trusty lieutenant and partner, the late Mr. Henry Sargent Codman. The death of this young man, which occurred last January, in his twenty-ninth year, is recognized as a serious loss to American gardening. He was a man of unusual promise, and his fate is deeply regretted, alike for his high ability and kindliness of heart, by the friends who knew him best.

The first exhibition of which we have any record, that held under the auspices of the Society of Arts in 1761, was largely composed of agricultural implements and machinery, and to gardeners it must be a source of much satisfaction to know that agriculture and its allied sciences—forestry and horticulture—have been given abundant prominence in nearly all the great shows which have succeeded that initial effort. It is admitted on all hands that the horticultural department of the Centennial Exhibition, held at Philadelphia in 1876, was not up to the standard of the time, but this assertion cannot be repeated with reference to horticulture at Chicago, nor is there the least uncertainty about the excellence of any of the other departments, unless it concerns that of public patronage and support. The magnificent Agricultural building, situated near the shore of the lake, is of the classic renaissance style of architecture, and its dimensions 500 by 800 feet. The Forestry building, perhaps the most novel in design and construction on the grounds, has a similar position, and is 500 feet long by 200 feet in width. It is of the rustic order, and not even a single nail has been used in its erection, wood being the material appropriately applied throughout.

While these departments possess many features of which fuller details would doubtless prove of absorbing interest to readers of the *Gardeners' Magazine*, it is necessary at this time to suppress further comment on them in order to touch briefly upon the salient points of matters in which the horticulturist pure and simple is more directly concerned. This leads us to the Horticultural building, illustrations of which have been spread broadcast. It was designed by Mr. W. L. B. Jenny, of Chicago, and is one of the most beautiful buildings connected with the exhibition, and is well located on the city side of the park, fronting on a large lagoon. It incloses a space 250×1,000 feet, and the great central dome is 187 feet in diameter and 113 feet high, or nearly twice the height of the great palm house at Kew. Underneath this dome is a massive rock-work mound, and most of the larger plants are here disposed. Draperies are formed of Cobæa scandens and other quick and strong growing climbers, large quantities of which have also been employed to clothe the arches, pillars, and rafters. The open court is provided with tanks reserved for water lilies, and a court of similar proportions in the opposite end of the

GOING TO THE GREAT EXPOSITION—THE TWENTY HOUR TRAIN FROM NEW YORK TO CHICAGO—VIEW ON THE MOHAWK RIVER.

building is to be filled with orange trees. All the tender plants not of gigantic size will find a good temporary home in the rear of the building, where the roof is of glass, while the front and ends are designed for the reception of the miscellaneous exhibits which do not require an extraordinary amount of light.

A large number of the exhibits of hardier plants are scattered about the grounds, and on a piece of land known as the "Wooded Island," in the body of water facing the Horticultural building. On this island, which is about fifteen acres in extent, place has also been found for an elaborate rose garden, which gives every indication of being gorgeous in the extreme, during the month of June. The exhibits raised on the grounds from seeds, such as primulas, calceolarias, cinerarias, etc., and the plants required for decorative purposes, have been, and some are still being cared for in a series of specially constructed greenhouses, while pools and ponds are utilized for aquatics. No deserving class of plants has been neglected, and the best of such kinds are shown in bewildering profusion. The preparation and adornment of the grounds has necessarily been a protracted and laborious work, but everything was found to be in an advanced stage on the eve of the opening day. Another month, or perhaps six weeks, must elapse before all the little details can be wrought out, but this delay is due more to climatic conditions than to tardy application.

The two men responsible for the horticultural department are Mr. John Thorpe and the Hon. John M. Samuels. The latter is a Kentuckian, highly educated and refined. He is forty-five years of age, and has been connected with the nursery trade since early boyhood. Having traveled a great deal in his native country and abroad, he is perfectly familiar with the horticultural possibilities and practices of all lands. His knowledge of fruits, especially those kinds cultivated in the southern portions of this country, is said to be phenomenal, and he is a thorough man of business. These qualifications have proved of immense value to him in the administration of a department which covers the wide field of horticulture. The phases of American horticulture alone are so varied, and its operations so extensive, that a man of less keen acumen would soon become seriously embarrassed in selecting for each its proper place, and in confining it to the space which its importance demands, and when the foreign element is confronted, the difficulties multiply beyond ready computation.

Mr. Thorpe, on the other hand, is more closely identified with the no less multifarious but much better limited interests of the floricultural community. He is a genuine, born gardener, and already well known to the readers of this journal as an authority on chrysanthemums and their culture. But although he has made a special study of these plants, his knowledge is by no means confined to them. He is a man of broad views, and his trained and powerful hand is seen in every movement for the advancement of floriculture in the United States during the past twenty years. One has but to compare the floriculture of Philadelphia in 1876 with that of Chicago in 1893 to find the real extent of this progress. It is a mighty onward stride. No better man could have been selected to guide the destinies of the floricultural division. Mr. Thorpe was born in England in 1842, and came to this country in 1874. It is to him that the influential Society of American Florists owes its existence. He was its first president, and now holds the same office in the American Chrysanthemum Society, another of his children; though his duties at Chicago have compelled him to neglect it somewhat of late. It is, however, gratifying to learn that he expects to be able to steer it into safe waters again ere long.

In addition to the exhibition, there are some other American institutions worth the attention of Europeans. The annual meeting of the Society of American Florists, to be held at St. Louis during the second week of August, is an event of importance, and should be attended by all who can possibly manage it. St. Louis is within easy distance of Chicago, and the most complete botanical garden in the United States may be seen there. The annual meeting of the American Seed Trade Association takes place in Chicago this year, August 14 to 16, and the International Horticultural Congress, to be held in connection with the Columbian Exposition, will convene on the latter date. Fairmount Park, Philadelphia, and Central Park, New York, deserve inspection from all visitors, as do the nurseries of Messrs. Pitcher & Manda, at Short Hills, New Jersey, and the rose establishment of Mr. John N. May, at Summit, New Jersey. These two commercial establishments are readily accessible from New York, and so is Dosoris, Glen Cove, the beautiful island home of Charles A. Dana, Esq., the editor of the *New York Sun*. The gardens at Dosoris are in charge of Mr. Wm. Falconer, and he can show visitors a great deal in the way of American horticulture, floriculture, and landscape gardening.

GOING TO THE COLUMBIAN EXPOSITION—THE TWENTY HOUR TRAIN FROM NEW YORK TO CHICAGO.

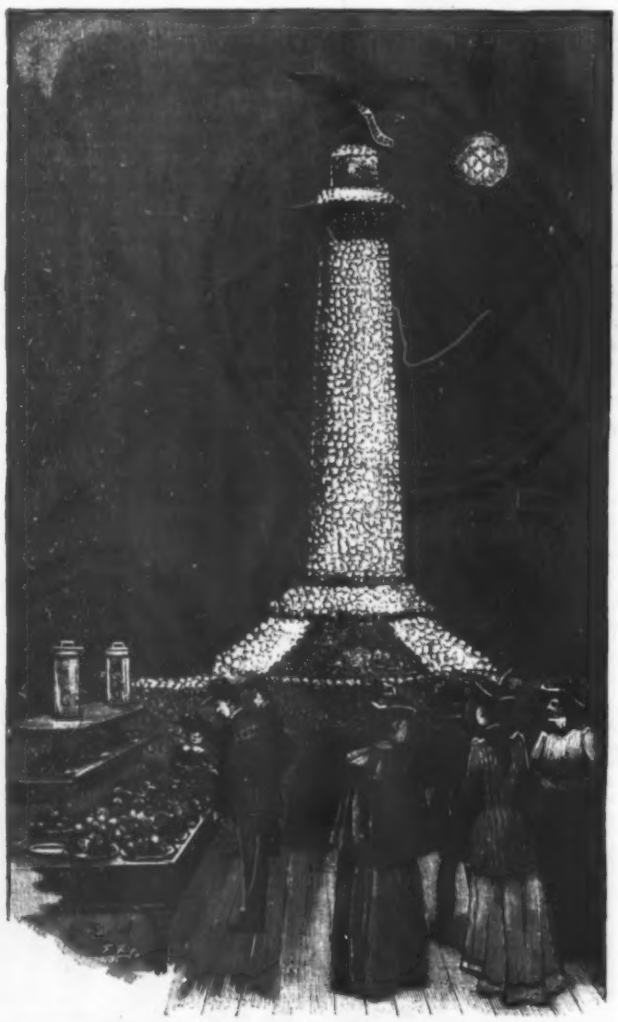
Then there are in the vicinity of Boston a few places of world-wide reputation. The famous Arnold Arboretum—fully described in recent numbers of the *Gardeners' Magazine*—is located at Forest Hills, a suburb of the city. The richest private collection of orchids in this continent, that of F. L. Ames, Esq., is a few miles out, at North Easton, Massachusetts. The gardener, Mr. Wm. Robinson, has a vast store of knowledge relating to orchids, and he grows them well albeit he does not forget the other branches of the profession, either inside or out of doors. In another direction from the city, also a few miles away in the country, we come upon the renowned establishment of H. H. Hunnewell, Esq., at Wellesley, Massachusetts. Here it is a Mr. F. F. Harris who presides over the garden, and all departments are well represented. There are a great many rare trees and shrubs on the grounds; the Italian garden, showing the only examples of topiary art to be found in the United States, is a prominent feature, and the general environment of the place is charming. The numerous greenhouses are amply stocked with the leading exotics, a large proportion of which are orchids in the best varieties. Adjoin-

ing this place are the residence and grounds of Walter H. Hunnewell, Esq., a gentleman whose able gardener, Mr. T. D. Hatfield, has attained an enviable position as a grower of chrysanthemums.

Newport, Rhode Island, is a delightful seaside resort in the summer months, sometimes called the Brighton of America. Many wealthy Americans own palatial mansions, with fitting parks, lawns and gardens, either in or near the city. The lawns especially are of matchless beauty, so refreshing and verdant in the scorching sun. The national capital, Washington, is another very attractive city. The noble government buildings, magnificent avenues lined with trees on either side, grand drives and squares adorned with shrubs, flowers and monuments, combine with rigid cleanliness and the bright clear sky to make it a place in which one might desire to live and dream away his days. The United States Botanic Garden and the grounds and greenhouses of the Agricultural department are open to the public, and the gardens and greenhouses attached to the White House, the official residence of the President, may be inspected on application to the gardener, Mr. Henry Pfister. The distances from New York to these gardening centers are—To Philadelphia, 90; Newport, 183; Washington, 227; Boston, 232; Chicago, 912; and St. Louis, 1065 miles. These figures are not so formidable as they seem at first sight, railroads of the United States affording better methods and greater comfort in traveling than any in Europe.

Some one, the poet Donne, I believe, has said that comparisons are odious. The phrase has long been proverbial, but I have always doubted the completeness of its wisdom. True as it may be in a degree, I still hold that it will not be altogether disagreeable, nor yet unprofitable, to come and see some at least of the things and places herein mentioned, and to range them side by side with the memories of other lands. It should be stated that there are thousands of other places, private, public and commercial, in the United States well worth a visit, circumstances permitting; but in view of the limited time that most persons can devote to this sort of thing, the writer has aimed to name only the best of representative types.

M. BARKER.



THE WORLD'S COLUMBIAN EXPOSITION—THE COLUMN OF ORANGES, 35 FEET HIGH, FROM LOS ANGELES, CALIFORNIA.

AT THE WORLD'S FAIR.

To European visitors the overcrowding of public vehicles in America seems to show an indifference to public safety on the part of the government which is almost criminal; but in Chicago, writes our special artist, this negligence is carried to an appalling extent. Some of the early trains running from Chicago city to the World's Fair were packed so full that they even had contingents of passengers clinging on to the locomotive. Neither the railway nor government officials interfered, and the crowd, eager to reach the Exhibition, traveled as it pleased.—The column of oranges which forms such a novel feature in the Horticultural building is the great exhibit from Los Angeles. Of late years orange orchards have extended enormously in that part of California, whence also comes a large exhibit of various other fruits. The column stands 35 ft. high and measures 14 ft. in circumference at the base.—*Black and White, London.*

The locomotive engraving on our first page is from sketches by Frederic Villiers, special artist for our cotemporary.

TECHNICAL EDUCATION.*

By MYER BLUMENFELD.

IF we look into the history of civilization, we cannot fail to acknowledge that the most conspicuous figure in it is the mechanic, who, in fact, has been the means of the world's advancement.

The civilization of a country is judged by its mechanical industries, which could not exist but for the skilled hand; therefore, we see what an important factor in the progress of a nation is the good workman; and how greatly an education of a technical character would contribute toward its advancement by increasing the number of mechanics. It is surprising that so little effort is made in our public school educational system to supply the want of such instruction. "A boy graduated from a public school has no occupation and is fit for none." He is quite ignorant of the useful callings or pursuits of life, ignorant of any manufactured article. By the instruction received in public schools it might appear that there are no such things as applied science, manual labor, machines and tools.

Mental improvement is, no doubt, an inappreciable blessing, but in order to execute an idea, the hand is needed as much as the brain. Thoughts are demonstrated by deeds. An idea is worth little unless it can give birth to a form corresponding with it; and this cannot be done, except by the aid of manual skill, upon which all improvements and progress depend. To the mechanic is due the utilization of steam as a motive power. Electricity owes its present exalted condition to the ingenuity of the mechanic, for the greatest electricians were mechanics. From the insignificant fact that amber, when rubbed, will attract light bodies, the mechanic has, by his practical applications, developed a power which, from the contrivances used for generating it, promises well to be the universal motive power of the future. So the steamboat, railroad, cotton gin, and hundreds of other inventions that have completely revolutionized society, have obtained for the mechanic an immortal fame, and demonstrated the value of a technical education.

To the skilled hand science is largely indebted for the means of its advancement. What a wonderful impulse to the spread of knowledge has been given by the telescope, microscope and the various other apparatuses now at the command of the scientific man!

We are apt to associate in our minds the use of tools with lack of education or refinement. The word mechanic suggests a grimy face and greasy hands; and it is this erroneous idea that drives thousands into pursuits not requiring mechanical skill, and they never live to achieve anything of importance in this world. Commercial cities are crowded with young men who have no ambition higher than to obtain a clerkship. They swarm in numbers, a burden to themselves and to their friends. This condition does not arise because there is nothing to do. In every branch of skilled industry there is an active demand for good workmen. In consequence of this, the poor boy who has no trade and the well educated college graduate together go begging for a place. This would not occur if the youth were taught the use of tools. A boy with a knowledge of scientific principles, who knows how to handle tools, will seldom have occasion to advertise for employment; thus the department of clerical labor would not be so crowded by thousands who are now regretting that they have no trade.

The cause of this scrambling for clerical office may be ascribed to the erroneous ideas that are entertained by parents concerning the trades. The ambition of parents to have their children rise in the world leads them to think that mechanical industry is demeaning. This false idea causes the misery and wreck of their children, who enter pursuits that afford them little or no reward. A doctor's or a lawyer's career is the foremost desire of parents for their sons. They do not even consider whether such professions may be overcrowded. The result is that very few succeed, and so many more unfortunates are driven into any work they can obtain, ascribing this lack of work to "hard times." To one that has received a technical education "hard times" seldom come. And why should they? Is he not prepared for the requirements of his work, improvements and changes? This education teaches him not only the trade, but its very principles, its science and its applications. Machines are continually being invented. Mechanics are called upon to manage them. They are needed constantly. It is, therefore, evident that a surer foundation for prosperity cannot be laid than by learning a trade *technically*. Mere shop experience cannot train one as does this education. It may teach a trade, but only a technical education will prepare one for the constant changes and improvements that may occur in his trade. It lifts one above the intelligence of his fellow-workmen. It inspires one with an ambition to succeed. It develops his thoughts, not confining him to the sphere of his labors, but expanding his mind to that of the improving of his work. An honest and industrious mechanic is a blessing to the community and a most desirable citizen.

It is time that blind prejudices concerning the trades give way to the true interests of youth. Technical schools should be encouraged and extended. Our much-to-be-regretted public school education should be changed to one that relates more closely to the pursuits of life. Then will the misery of lack of work and overcrowding in the professions be abolished, the country become prosperous and happiness prevail.

* Prize essay, delivered at the Hebrew Technical Institute, New York, commencement, June 16, 1893.

THE NEEDS AND OPPORTUNITIES OF A GREAT TECHNICAL COLLEGE.

By Dr. R. H. THURSTON, Director of Sibley College, Cornell University, Ithaca, N. Y.

VERY few laymen have a knowledge or even a conception of the magnitude of the work of educating a nation, and perhaps fewer still have any idea of the bearing of that work upon the prosperity and intellectual position of a country, among the nations of the earth. When we are told that there are in the United States about 40,000,000 of children requiring instruction, 20,000,000 who have, or who will ask, secondary education, and at least 100,000 young men and women capable of and rightly demanding the opportunity of securing higher education, we get some slight idea of the facts of the case. When we are told that the United States government has given to the cause of education 150,000,000 acres of public lands, and that Cornell University alone has sold over $5,000,000 worth of her endowment, and has still 5,000 good farms left for sale, that States sometimes expend as much as $25 per capita of their population, and cities as much as $35 on their public schools, we get a better idea of the extent to which a people makes sacrifices of wealth for the benefit of the rising generation. Above $100,000,000 are spent annually by the American commonwealth on education, maintaining 200,000 schools and their 300,000 teachers; two-thirds of whom, by the way, are women. Even greater sums, proportionally, are spent in some instances by European states. Prussia spent $4,000,000 on its great technical school at Charlottenburg. Zurich has spent about $500,000 on its great chemical and physical laboratories at its "Polytechnicum." Saxony, half the size of Vermont, pays out nearly $500,000 annually on its university. The endowments of Harvard University are between $6,000,000 and $8,000,000; those of Johns Hopkins are $4,000,000 or $5,000,000, and those of Cornell and of Columbia fall between these enormous figures. The universities organized by the States as recipients of the famous land grant of 1862, and which, in the West, are usually the apex of the educational pyramid of the State, are supported by a State tax varying from one-tenth of a mill down, and the State is coming to be the parent of the educational system throughout that section of the country.

But great as are the endowments and large as are the appropriations for education on both sides of the Atlantic, the work is but just begun, and we give, in the following paragraphs, some idea of the needs and the opportunities of our New York State institution of higher education, in those departments which most concern and interest the readers of this journal. Contrary to the custom in the States above alluded to, New York, however, has never contributed to the work of promotion of education bearing especially upon agriculture and the mechanic arts, and has neither levied a State tax, as is usual in other States, nor given any large sums by direct appropriation. Until the present year the State had never given a dollar from its own resources to the "Land Grant College" of the State; but had simply turned over to it the contributions received from the United States Treasury. The last legislature appropriated $50,000 for a new building needed by the agricultural department.

Meantime, the State has compelled the University to educate without charge over 500 students at a cost to the institution of over $150,000 a year. This

expense is met by the income received from the gifts of Mr. Cornell and others, which now aggregate several millions, and constitute the endowment above mentioned. The load is greater, however, than the university can carry, and it is now running behind and must find new friends, secure fair compensation from the State, or tax and reduce the number of its own paying students. The president and trustees have appealed to the State to relieve them from this embarrassment; but the only response thus far has been the contribution of the estimated cost of one new structure, which will, when finished, still further load the university by its annual costs of maintenance, some $4,000 or $5,000. The excess of expenditures over receipts during the current year is stated to be $36,000, and the excess of costs of instruction of the State free scholarship appointments over receipts from the State are $150,000.

In what follows, the work and requirements and the opportunities for further good work on the part of its school of engineering and mechanic arts only are referred to; but similar opportunities and similar good work may be probably found characterizing every great institution of learning in the country. This is especially true in the Eastern States, where their work is sustained wholly or mainly by private liberality of the wealthy classes. These extracts are from a statement made to the trustees of Cornell University and the friends of the college by the Director of Sibley College, the largest of the professional schools of the university; from which school graduate, this year, over one hundred students in mechanical engineering, about one-half of whom are especially trained as electricians. This is by far the largest body of young men yet passing into the profession from any school or college known to us. The paper gives some idea not only of the magnitude and importance of the work of any one of our great schools of engineering, but, and especially, of the fact that the larger the institution and the greater its work, the more certainly will its needs and its opportunities transcend its power of meeting them. The people are sure to ask of such an institution, at all times, more and more proportionally as it grows in extent of its work and in its usefulness. Otherwise, as stated by the writer of this paper, in one of his earlier communications: "The more liberal the endowment, the more certainly and in higher proportion will success be assured. Each dollar added accomplishes more than a dollar previously expended. The foundations are laid, largely out of sight; but the superstructure rises more and more into view as the edifice is built up, and every added part is more visible and more evidently useful than that which lies beneath." The larger the business in education, as elsewhere, the larger the opportunity for the still more profitable use of additional capital; and this is true of every successful college in the country. All need, and can profitably use, vastly larger endowments than they have or are likely to have. For Cornell University and Sibley College, in the following article, read the name of any other large institution of learning, and the language will apply equally well.

"SIBLEY COLLEGE, during the year 1892-3, exhibited continued growth in number of students and strength of its course. The number of regular undergraduate students enrolled during the year, as given in the University register, for each year, has been as below:

	'85.	'86.	'87.	'88.	'89.	'90.	'91.	'92.	'93.
Enrolled....	63	106	168	220	283	369	438	501	546
Graduated..	5*	19	23	32	54	52	90	95	107

"The number of graduate students has also gradually risen to about 30, the present year, and the number of 'special' students, formerly comparatively numerous, has fallen to 9. The total enrollment for the year 1892-3 has thus been nearly 600 in Sibley College alone and about 1,700 for the University as a whole, Sibley College having recently registered about one-third.

"It is sufficiently evident that, so far as numbers of students are an index of its efficiency, the college is shown to have become successful to a degree that gratifies, even if it does not yet fully satisfy, every friend of the great educational movement of which it is the index. Its purpose, as declared in the statutes upon which the University is founded, is mainly to promote the welfare of the 'industrial classes' by furnishing them opportunities for 'liberal and practical education' in the vocations in which they engage. The undergraduate courses in Sibley College and in the College of Agriculture may be considered as the immediate outcome of, and answer to, this demand. The requirement is met to-day in a very remarkably complete manner by the operation of these courses, and the only difficulties standing in the way of still further and indefinite advance are pecuniary. Given the needed capital, and the college may readily be converted into a 'technical university.' At the moment, the high tuition fees which it is necessary to exact from this particular body of students, and the inability to provide for extension of the upper grades of instruction in the development of special departments of engineering, or even to provide the number of teachers and quality of instruction desirable, are the serious obstacles to further progress. Up to its limit, however, the work of the college may be said to be satisfactory. In fact, students now come to Cornell University from all other great colleges and from all the technical schools—in fact, from all parts of the world—to secure the instruction which is here offered in our undergraduate as well as our graduate courses. Students have come from England, from Australia, from the Pacific coast, and from the West Indian Islands. Graduates of Harvard and Yale, from the University of London and from the University of Sydney, and from literary and technical schools of all grades, are with us pursuing studies or engaged in researches, such as are the usual work of our own students.

"THE OPPORTUNITIES OF CORNELL UNIVERSITY, in the field assigned as the peculiar province of the various departments of Sibley College and of its present and prospective schools are vastly greater than her needs and grander than her present and immediately prospective visible accomplishment, great as are both. The most crying need of this country and of this State is a complete and well organized and properly proportioned and inter-related system of technical instruction for the people, beginning with primary and manual training schools, including the trade school system. This last now constituting a network covering every country in Europe, but is almost unknown in the United States, and is here overtopped by such higher schools and colleges as this is coming to be. Cornell University, however, still possesses no such magnificent and fruitful departments of research, the highest branch of culture, whether in literature, science, or the arts of construction, as are sustained by some of the smallest states of Europe. Our opportunities lie here, more than in any other possible line of work. So long as our country is in a position to profit by the foundation of twenty technical universities, such as are not even seen in any one instance in the United States, of fifty trade schools and colleges, such as this is the germ of, simply, and of 2,000 technical high schools and manual training schools, which numbers represent the proportion in which such schools exist in the best educated countries of Europe, Cornell University and Sibley College will never lack for opportunity. Two thousand professors and 25,000 students should be to-day engaged in teaching and study in universities and colleges like this.

"Such opportunities as here exist are especially promising where a beginning has already been made. Outside the essential work of the college as now established, there are a number of singularly grand opportunities for the promotion of great and fruitful work.

"In art, there is to-day no suitable provision for such instruction as is desirable and such as would be creditable to a great university like Cornell. The art section of the Sibley College department of drawing and art has been well started, however, on a small scale, and the instruction furnished during recent years in free hand drawing, sketching, water color work, modeling, and its special occasional work, as china decoration, is of such quality as to attract the pleased attention of all visitors interested in the subject and to show that the foundation of what may readily, with sufficient capital, be made a splendid superstructure. Industrial art is the main outcome and purpose of this work and the reason of its prosecution; but there is here a grand opportunity to develop a school of art in which art shall be pursued for art's sake, and in which painting and sculpture shall find a home suitable alike to their great mission and to the standing of the university which gives them place.

"A still grander opportunity, in some respects, and unquestionably greater in the promotion of the primary purpose of our organization, is to be found in the formal foundation and organization of a department for research, raising it upon the foundation already well and solidly laid in our 'mechanical laboratory.' As was remarked in the Sibley College *Journal*, recently:

"'Outside the plans of the founder and his son, now adopted as an architectural working hypothesis, there is, at the moment, but one other structure imperatively needed; and it is hoped that some well-to-do friend of the university, interested in the work of Sibley College in applied science and in engineering, and especially in research, may be glad, ere long, to build and endow it, and to give it his name, as a contribution to science and technical education and as a memorial to be a source of pride and pleasure to his posterity, so long as Cornell University and Sibley College shall endure. This is the much-needed engineering laboratory for research in applied science and in professional work, and for the better instruction of classes in that department, experimental engineering, which is now doing such admirable work. Perhaps no other department in the University is now so much in need of assistance as is this. It has been impossible, for two years past, or more, to even accept all the good things our friends would give us to improve our equipment, in consequence of lack of space in which to install them. Whole departments of engineering science remain unexplored, and important subjects must be left untaught, notwithstanding their great importance, for lack of space and because of our inability to add to our equipment in these departments. A quarter of a million of dollars could be economically expended in the erection of this structure, which would be a nobler monument than ever was erected in this country to any generous patron of higher education. Its operation would do more to promote the welfare of our State, of our nation, and of the world, than probably could an equal expenditure in any field yet discovered by philanthropists or statesmen. Contributions of positive knowledge in the applied sciences, and especially in the departments of the mechanic arts and of engineering, will do more for mankind than all else together; and the promotion of scientific methods and the addition to our knowledge of facts and data bearing upon the constructive arts is in the direct line of progress. Even with the limited facilities which it has been possible to collect to date at Sibley College, through the generous action of our many friends, a wonderful amount of work has been performed in these directions, while at the same time giving what is thought to be an admirable course of regular instruction in the methods of scientific investigation as applied in engineering, and in teaching the practical use of every important instrument or apparatus employed by the engineer. Extensive work has been done in the testing of the materials of engineering and general construction; some original research has resulted in real advances in professional and in scientific knowledge; some important discoveries have been made, and occasionally an invention of value has been developed through the opportunities and in consequence of the healthful stimulus of this section of the course in mechanical engineering. In justice to the University, to the College, and to the corps of intelligent and earnest and industrious workers who have charge of this department, it is hoped that a laboratory of engineering research may soon be erected as the next step of our rapid but healthy growth.'

"All this is perfectly true, and even with the present limited facilities and with a corps of instruction overloaded and overworked in all directions, and with only the present small body of graduate students engaged in research, we have supplied a very large amount of valuable and original matter to the technical and professional journals. It is difficult to imagine what may not be the result of the operation of a well-endowed department devoted, from senior professor to youngest student, to the prosecution of investigations seeking to reveal the facts and principles upon the application of which all our material and much of our intellectual progress depends. Chemical and physical laboratories and astronomical observatories, although numerous, and often productive of valuable work, in this country as well as in Europe, are none too common or too well equipped; but in the field of engineering, where ten are needed for one laboratory of pure science, we actually have not one, where there are many of the other kind. One such laboratory of engineering research at Cornell, well equipped and handsomely endowed, would do more for the promotion of the welfare of the people than is accomplished in the whole country, in this direction, to-day, and more than could possibly any similar expenditure in less immediately and practically important directions.

"The foundation of schools of the mechanic arts, of so-called trade schools, of which hundreds dot the soil of Europe, of which we have not a dozen of importance in our whole country, constitutes another of the opportunities presented for investment of funds at Cornell University and in connection with Sibley College. It was in this direction that the sympathies of Mr. Cornell were most strongly called out. His idea of the establishment of such schools in such manner that students working in them should be able, to some extent, at least, to earn their expenses, although proving impracticable, illustrates the fertility of his philanthropy. A system of schools of the trades, of wood working, of blacksmithing, of foundry and machine shop practice, such as constitute a portion of the present organization, but devoted especially and explicitly to the instruction of young men of less, or even of no, knowledge of the higher mathematics, or languages—technical and trade schools for the average mechanic—would do even more good than a new school of engineering, if founded upon a sufficiently large and strong basis. Weaving schools, numerous in Europe, unknown in this country, and needed more than our people can realize until they discover how far their absence deprives them of their own markets for textiles, are trade schools which, once established here, would lend us reputation, entitle the founder and the University to the gratitude of the whole nation, and ultimately extend and reform our whole system of textile manufactures. To-day, all our designers of textiles, practically, are educated abroad, and are commonly imported foreign-born workmen. To-day, Europe has a substantial monopoly of many of the finer and best-paying varieties of silks and woolens, such as should be principally supplied this market by our own spinners and weavers. The foundation of weaving schools at Cornell University would do more for the country than can the establishment of churches, hospitals, or professional schools for the always over-crowded 'learned professions.' We are, and have been from the beginning, building onward and always upward in the progress of our University. There exists a splendid opportunity for any well-to-do friend of the people to build these trade schools on the broader and lower levels on which the 'industrial classes,' for whom the law and the charter of Cornell University were written, must mainly work; levels above which circumstances are continually raising the work of the present Cornell higher and higher, forcing it up more and more out of the field originally proposed for the University.

"Schools of engineering of special kinds, nevertheless, are needed, and imperatively, and on the plane of our graduate schools. Our long-hoped-for graduate schools of locomotive and railway engineering, perhaps having the broadest of all fields of application in this country of nearly 200,000 miles of railway, having half the existing lines of the world, remain still to be organized. For this we need $100,000 to $150,000 in buildings, equipment, and materials and endowment, or an assured income, giving us not less than $10,000 a year, and we could spend, probably, still more profitably, two or three times that sum. Once organized, it is very likely that the railroads, seeing what advantage its operation would have for them, would do much to sustain and promote its work. The extent to which experimental investigation is needed and demanded by the railways of the country, even now, is hardly conceivable by the layman; what could be done in research for this branch of our industrial system by the laboratories of such a school and their operation in conjunction with those of the College and of the University is perhaps hardly conceivable by even the professional. No branch of professional engineering presents a larger opportunity to the proposing founder of a great technical school of the higher rank than this. The existence, already, at this point, of large and successful schools of engineering, with their large equipments, extensive laboratories, and mutually helpful courses, renders this the natural and especially desirable location for the proposed new schools. Aggregating about this already established nucleus, they would be certain both of permanent and steady growth in magnitude and usefulness and of that highest efficiency which can only be attained in such an atmosphere as exists where a variety of both similar and dissimilar institutions are collected to assist each other by mutual direct aid and by that stimulus which comes of wholesome and friendly rivalry.

"Among the great opportunities of the world, in the promotion of the best interests of the people, are those to-day to be found at Cornell University and largely in connection with the organization of Sibley College. Original research is now universally recognized as the 'essential preliminary to the fullest development of industry,' and the thousands of schools of France and Germany and all their technical colleges and their universities, whether technical or other, are organized in recognition of this fact. The hundred weaving and designing schools of England, her technical colleges, and her trade schools are taking a similar constitution, and in Manchester alone 14,000 students are nightly profiting by the systematic manner in which that nation has entered upon the task here set before Cornell University by our own nation and State. Yet nowhere can be found a better substructure and larger opportunities for the erection of an orderly and systematically planned and mutually helpful aggregation of colleges and schools than in the United States and at Cornell University to-day.

"Besides the schools and colleges needed and desira-

* Until 1886 no students in electricity were formally registered in Sibley College.

ble, another need and opportunity is to be found in the establishment of scholarships and fellowships—especially the latter—for deserving and talented men. Nothing can do more to insure the attendance of the most desirable class of students and the prosecution of the highest and best work in any direction than the presence, as a nucleus, of a body of able and earnest men such as invariably composes the list of fellows in any institution. Sibley College, the largest section of the University, is in this respect destitute, though deserving. One scholarship, that founded by Mr. Padgham, in memory of his son, and the possibility of securing scholarships and a fellowship among those open to the whole University, constitute the only present special advantages of the College in this respect. The proportion assignable, on the basis of numbers, would be very large; but the advantages which may be now offered students in the direction of higher research are so great that the assignment or the foundation of fifteen or twenty fellowships would undoubtedly prove a great help to the University and the College, as well as to the students thus aided, and to the country to which they, in turn, would prove inexpressibly helpful.

"Graduate work is here already remarkably successful; but it can be made vastly more so by the promotion of this kind of work through fellowships and otherwise. The men who do this work are the strongest and best men coming to the College, and carry away with them an influence that no institution can afford to ignore."

RULES FOR SAFE WIRING.*

CENTRAL STATIONS—CLASS A—FOR LIGHT OR POWER.

THESE rules also apply to dynamo rooms in isolated plants connected with or detached from buildings used for other purposes, also to all varieties of apparatus of both high and low potential.

Generators or motors must be:

1. Located in a dry place.
2. Insulated on floors or base frames, which must be kept filled to prevent absorption of moisture, and also kept clean and dry.
3. Not exposed to flying or combustible materials.
4. Each covered with waterproof cover when not operating.

In no case must a generator be placed in a room where any hazardous process is carried on, such as the working room of a cotton, jute, flax, woolen or flour mill.

Care and Attendance.—A competent man must be kept on duty in the room where generators are operating.

Oily waste must be kept in metal cans and removed daily.

Conductors.—From generators, switchboards, rheostats or other instruments, and thence to outside lines, conductors must be:

1. In plain sight.
2. Wholly on non-combustible insulators, such as glass or porcelain.
3. Separated by non-combustible insulating tubes from contact with floors, partitions or walls through which they may pass.
4. Kept rigidly so far apart that they cannot come in contact.
5. Covered with non-inflammable insulating material sufficient to prevent accidental contact.
6. Ample in carrying capacity, to prevent heating. (See "Capacity of Wires" table.)
7. Connected by splices or joints equal in carrying capacity to the conductors themselves, soldered, if necessary, to make them efficient and permanent.
8. When under floors or in distributing towers, placed in spaces ample for inspection and ventilation, and provided with special insulating covering.

Switchboards must be:

1. So placed as to make it impossible to communicate fire to surrounding combustible material; accessible from all sides when the connections are on the back, or may be placed against a brick or stone wall when the connections are entirely on the face.
2. Kept free from moisture.
3. Made of non-combustible material or of hard wood, filled to prevent absorption of moisture.
4. Equipped with bars and wires in accordance with Rules 1, 2, 3, 4, 5, 6 and 7 for placing conductors.

Resistance boxes and equalizers must be:

1. Equipped with metal or non-combustible frames.
2. Treated as sources of heat.
3. Placed on the switch, or a distance of a foot from combustible material, or separated therefrom by asbestos or cement.

Lightning arresters must be:

1. Attached to each side of every overhead circuit connected with the station.
2. In plain sight.
3. On the switchboard, or in an equally accessible place, away from combustible material.
4. Connected with at least two earths by separate wires of large size.
5. So constructed as not to maintain an arc after the discharge has passed.

Testing.—All series and alternating circuits must be tested every two hours while in operation, to discover any leakage to earth, abnormal in view of the potential and method of operation.

All multiple-arc low potential systems (300 volts or less) must be provided with an indicating or detecting device, readily attachable, to afford easy means of testing where the station operates perpetually.

Data obtained from all tests must be preserved for examination by insurance inspectors.

CLASS B—ARC (SERIES) SYSTEMS.

Overhead conductors.—All outside overhead conductors (including services) must be:

1. Covered with some insulating material not easily abraded.
2. Firmly secured to properly insulated and substantially built supports, all the wires having an insulation equal to that of the conductors they confine.
3. So placed that moisture cannot form a cross connection between them, not less than a foot apart, and not in contact with any substance other than proper insulating supports.
4. At least seven feet above the highest point of flat roofs, and at least one foot above the ridge of pitched roofs, over which they pass or to which they are attached.
5. Protected, whenever necessary, in view of possible accidents to conductors or supports, from possibility of contact with other conducting wires or substances to which current may leak, by *dead insulated guard irons or wires.* Special precautions of this kind must be taken where sharp angles occur, or where any wires might possibly come in contact with electric light or power wires.
6. Provided with petticoat insulators of glass or porcelain. Porcelain knobs and rubber hooks are prohibited.
7. So spliced or joined as to be both mechanically and electrically secure without solder. They must then be soldered to insure preservation, and covered with an insulation equal to that on the conductors.

The following formula for soldering fluid is approved:

Saturated solution of zinc	5 parts.
Alcohol	4 parts.
Glycerine	1 part.

Conductors should not be run over or attached to buildings other than those in which light or power is being or is to be used, but on separate poles or structure always easily inspected.

Service blocks must be covered over their entire surface with at least two coats of waterproof paint, and so maintained.

Telegraph, telephone and similar wires must not be placed on the same arm with electric or power wires, and *should not* be placed on the same structure or pole.

INTERIOR CONDUCTORS.

All interior conductors must be:

1. Where they enter buildings from outside terminal insulators to and through the walls, covered with extra waterproof insulation, and must have drip loops outside, preferably slanting upward toward the inside, and bushed with waterproof and non-combustible insulating tube.
2. Arranged to enter and leave the building through a double contact service switch, which will effectually close the main circuit, and disconnect the interior wires when it is turned "off." The switch must be so constructed that it shall be automatic in its action, not stopping between points when started, and prevent an arc between the points under all circumstances; it must indicate on inspection whether the current be "on" or "off," and be mounted on a non-combustible base in a position where it can be kept free from moisture and easy of access to police or firemen.
3. Always in plain sight, never covered, except in special cases, where an armored tube may be necessary.
4. Covered in all cases with a waterproof non-combustible material that will adhere to the wire, not fray by friction, and bear a temperature of 150° F. without softening.
5. In dry places, kept rigidly apart at least ten inches, except when covered (in addition to insulation) by waterproof, non-conducting and non-inflammable tubing which must be strong enough to protect the insulating covering from injury. Conductors thus placed may be run not less than three inches apart, and be fastened with staples, under which are placed mechanically rigid insulating strips or saddles of greater width than the metal of the staple, by which possibility of injury to the tube may be prevented.
6. In damp places, attached to glass or porcelain insulators, and separated ten inches or more.
7. When passing through walls, floors, timbers or partitions, treated as in central stations under like conditions.

LAMPS AND OTHER DEVICES.

Arc lamps must be in every case:

1. Carefully isolated from inflammable material.
2. Provided at all times with a glass globe surrounding the arc, securely fastened upon a closed base. No broken or cracked globes may be used.
3. Provided with a hand switch, also an automatic switch, that will shunt the current around the carbons, should they fail to feed properly.
4. Provided with reliable stops to prevent carbons from falling out in case the clamps become loose.
5. Carefully insulated from the circuit in all their exposed parts.
6. Where inflammable material is near or under the lamps, provided with a wire netting around the globe and a spark arrester above, to prevent escape of sparks, melted copper or carbon.

Incandescent lamps in series circuits, having a maximum potential of 350 volts or over, must be governed by the same rules as for arc lights, and each series lamp provided with a hand switch and automatic cut-out switch; when lights are in multiple series, such switches and cut-outs must not control less than a single group of lights. Electro-magnetic devices for switches are not approved.

Under no circumstances will incandescent lamps on series circuits be allowed to be attached to gas fixtures.

CLASS C—INCANDESCENT (LOW PRESSURE) SYSTEMS—300 VOLTS OR LESS—OVERHEAD CONDUCTORS.

Outside overhead conductors must be:

1. Erected in accordance with general rules for arc (series) circuit conductors.
2. Separated not less than six inches, where they enter buildings as service conductors, and be provided with a double pole fusible cut-out, as near as possible to the point of entrance to the building, and outside the walls when practicable.

UNDERGROUND CONDUCTORS.

Underground conductors must be:

1. Provided with suitable protecting devices at the ends of tube or conduit services inside the walls of buildings, as a guard against moisture and injury.
2. Terminated at a properly placed double-pole house cut-out.
3. Of specially insulated conductors after leaving the tube or conduit, and separated by at least 10 inches, until the double-pole cut-out is reached.

INSIDE WIRING.

Wire should be so placed that in the event of the failure or deterioration of their insulating covering the conductors will still remain insulated.

At the entrance of every building there shall be a double-pole switch place in the service conductors, whereby the current may be entirely cut off.

Conductors must not be:

1. Of sizes smaller than No. 16 B. & S., No. 18 B. W. G., or No. 3 E. S. G.
2. Lead or paraffine covered.
3. Covered with soft rubber tube.
4. Laid in mouldings of any kind in damp places.
5. Laid in mouldings with open grooves against the wall or ceiling.
6. Laid in mouldings where less than half an inch of solid insulation is between parallel wire, and between wires and walls or ceilings.
7. Laid in plaster, cement, or similar finish, without an exterior metallic protection.
8. Mouldings, where admissible, must have at least two coatings of waterproof paint, to be impregnated with a moisture repellant.

Cleat work is not desirable, and cleats must *not* be used unless:

1. In a very dry place.
2. In a place perfectly open for inspection at any time.
3. They are of porcelain, or well seasoned wood, filled, to prevent absorption of moisture.
4. They are so arranged that wires of opposite polarity, with a difference of potential of 150 volts or less, will be kept at least two and one-half inches apart, and that where a higher voltage is used this distance be increased proportionately.
5. There is a backing provided of wood at least half an inch thick, well seasoned and filled, to prevent absorption of moisture.

Metal staples must never be used to fasten conductors unless:

1. Provided with an insulating sleeve or saddle rigidly attached to the metal of the staple, and having such strength and surface as to prevent mechanical injury to the insulation of the conductor.
2. Under conditions in which cleat work would be acceptable, or where driven into a moulding specially adapted for open work.

SPECIAL WIRING.

Wherever conductors cross gas, water, or other metallic pipes, or any other conductors or conducting material (except arc light wires), they should be separated therefrom by some continuous non-conductor at least one inch. In crossing arc light wires the low tension conductors must be placed at a distance of at least six inches. In wet places an air space must be left between conductors and pipes in crossing, and the former must be run in such a way that they cannot come in contact with the pipe accidentally. Wires should be run *over* all pipes upon which condensed moisture is likely to gather, or which by leakage might cause trouble on a circuit.

In rooms where inflammable gases may exist, or where the atmosphere is damp, the incandescent lamp and socket should be inclosed in a vapor-tight globe. This is not to be understood to include rooms where illuminating gases are used in the ordinary manner.

In breweries, stables, dye houses, paper and pulp mills, or other buildings specially liable to moisture, all conductors, except where used for pendants, must be:

1. Separated at least six inches.
2. Provided with a durable, moisture-proof covering.
3. Carefully put up.
4. Supported by porcelain or glass insulators.

Moisture-proof and non-inflammable tubing may be accepted in lieu of such construction.

No switches or fusible cut-outs will be allowed in such places.

Interior conduits must not be:

1. Combustible.
2. Of such material or construction that will be injured by plaster, cement, or other surrounding material, or that the insulation of the conductor will ultimately be injured or destroyed by the elements of its composition.
3. So constructed or placed that difficulty will be experienced in removing or replacing the conductors.
4. Subject to mechanical injury by saws, chisels or nails.
5. Supplied with a twin conductor in a single tube where a current of more than ten amperes is expected.
6. Depended upon for insulation. The conductors should be covered with moisture-proof material.

The object of a tube or conduit is to facilitate the insertion or extraction of the conductors, to protect them from mechanical injury and, as far as possible, from moisture.

Twin tube conductors must not be separated from each other by rubber or similar material, but by cotton, or other readily carbonizable substance.

Conductors passing through walls or ceilings must be incased in a suitable tubing, which must extend at least one inch beyond the finished surface until the mortar, or other similar material, be entirely dry, when the projection may be reduced to half an inch.

Double-pole safety cut-outs must be:

1. Placed where the overhead or underground conductors enter a building and join the inside wires.
2. Placed at every point where a change is made in the size of the wire (unless the cut-out in the larger wire will protect the smaller). This includes all flexible conductors. All such junctions must be in plain sight.
3. Constructed with bases of non-combustible and moisture-proof material.
4. So constructed and placed that an arc cannot be maintained between the terminals by the fusing of the metal.
5. So placed that on any combination fixture no group of lamps requiring a current of six amperes or more shall be ultimately dependent upon one cut-out.
6. Wherever used for more than six amperes (or where the plug or equivalent device is not used),

* Adopted by the National Electric Light Association at their Fourteenth Convention, held at Montreal, Canada, September 7, 8, 9, 10, 1891. Revised at their Fifteenth Convention, held at Buffalo, N. Y., February 23, 24, 25, 1893.

equipped with fusible strips or wires, provided with contact surfaces or tips of harder metal soldered or otherwise, having perfect electrical connection with the fusible part of the strip.

Safety fuses must be so proportioned to the conductors they are intended to protect that they will melt before the maximum safe carrying capacity of the wire is exceeded.

All fuses, where possible, must be stamped or otherwise marked with the number of amperes equal to the safe carrying capacity of the wire they protect.

All cut-out blocks when installed must be similarly marked.

The safe carrying capacity of a wire changes under different circumstances, being about forty per cent. less when the wire is closed in a tube or piece of moulding than when bare and exposed to the air, when the heat is rapidly radiated. It must be clearly understood that the size of the fuse depends upon the size of the smallest conductor it protects, and not upon the amount of current to be used on the circuit. Below is a table showing the safe carrying capacity of conductors of different sizes in Birmingham, Brown & Sharpe and Edison gauges, which must be followed in the placing of interior conductors.

Brown & Sharpe.		Birmingham.		Edison Standard.	
Gauge No.	Amperes.	Gauge No.	Amperes.	Gauge No.	Amperes.
0000	175	0000	175	200	175
000	145	000	150	180	160
00	120	00	130	140	135
0	100	0	110	110	110
1	95	1	95	90	95
2	70	2	85	80	85
3	60	3	75	65	75
4	50	4	65	55	65
5	45	5	60	50	60
6	35	6	50	40	50
7	30	7	45	30	40
8	25	8	35	25	35
10	20	10	30	20	30
12	15	12	20	12	20
14	10	14	15	8	15
16	5	16	10	5	10
		18	5	3	5

Switches must:

1. Be mounted on moisture-proof and incombustible bases, such as slate or porcelain.
2. Be double pole when the circuits which they control are connected to the fixtures attached to gas pipes, and when six amperes or more are to pass through them.
3. Have a firm and secure contact, must make and break readily, and not stick when motion has once been imparted by the handle.
4. Have carrying capacity sufficient to prevent heating above the surrounding atmosphere.
5. Be placed in dry, accessible places, and be grouped as far as possible, being mounted, when practicable, upon slate or equally indestructible backboards.

MOTORS.

In wiring for motive power, the same precautions must be taken as with the current of the same volume and potential for lighting. The motor and resistance box must be protected by a double-pole cut-out and controlled by a double-pole switch.

Arc lights on low potential circuits must be:

1. Supplied by branch conductors not smaller than No. 12 B. and S. gauge.
2. Connected with main conductors only through double-pole cut-outs.
3. Only furnished with such resistances or regulators as are inclosed in non-combustible material, such resistances being treated as sources of heat.
4. Supplied with globes protected as in the cases of arc lights on high potential circuits.

FIXTURE WORK.

1. In all cases where conductors are concealed within or attached to fixtures, the latter must be insulated from the gas pipe system of the building.
2. When wired outside, the conductors must be so secured as not to be cut or abraded by the pressure of the fastenings or motion of the fixtures.
3. All conductors for fixture work must have a waterproof insulation that is durable and not easily abraded, and must not in any case be smaller than No. 16 B. and S. No. 18 B. W. G., or No. 3 E. S. G.
4. All burrs or fins must be removed before the conductors are drawn into a fixture.
5. The tendency to condensation within the pipes must be guarded against by sealing the upper end of the fixture.
6. No combination fixture in which the conductors are concealed in a space less than one-fourth inch between the inside pipe and the outside casing will be approved.
7. Each fixture must be tested for possible "contacts" between conductors and fixture and for "short circuits" before the fixture is connected to its supply conductors.
8. The ceiling blocks of fixtures should be made of insulating material.

ELECTRIC GAS LIGHTING.

Where electric gas lighting is to be used on the same fixture with the electric light:

1. No part of the gas piping or fixture shall be in electrical connection with the gas lighting circuit.
2. The wires used with the fixture must have a non-inflammable insulation, or, where concealed between the pipe and shell of the fixture, the insulation must be such as is required for fixture wiring for the electric light.
3. The whole installation must be free from "grounds."
4. The two installations must test perfectly free of connection with each other.

PENDANTS AND SOCKETS.

No portion of the lamp socket exposed to contact with outside objects must be allowed to come into electrical contact with either of the conductors.

Cord pendants must be:

1. Made of conductors, each of which is composed of several strands insulated from the other conductor by a mechanical separator of carbonizable material, and both surrounded in damp places with a moisture-proof and non-inflammable layer.
2. Protected by insulating bushings where the cord enters the socket.
3. So suspended that the entire weight of the socket and lamp will be borne by knots above the point where the cord comes through the ceiling block or rosette, in order that the strain may be taken from the joints and binding screws. All sockets used for wire or cord pendants should have openings at least equal to one-quarter inch gas pipe size.
4. Allowed to sustain nothing heavier than a four-light cluster, and in such a case special provision should be made by an extra heavy cord or wire as a mechanical re-enforcement.
5. Equipped with keyless sockets, as far as practicable, controlled by wall switches. In no case may a lamp giving more than a fifty candle power be placed in a key socket on a flexible pendant.

CLASS D—ALTERNATING SYSTEMS—CONVERTERS OR TRANSFORMERS.

Converters must not:

1. Be placed inside of any building, except the central station, unless as hereinafter provided.
2. Be placed in any but metallic or non-combustible cases.
3. Be attached to the outside walls of buildings unless separated therefrom by substantial insulating supports.
4. Be placed in any other than a dry and convenient location (which can be secured from opening into the interior of the building, such as a vault) when an underground service is used.
5. Be placed without safety fuses at the junction between main and service conductors, and safety fuses in the secondary circuits where they will not be affected by the heat of the converter.

PRIMARY CONDUCTORS.

In those cases where it may not be possible to exclude the transformers and primary wires entirely from the building, the following precautions must be strictly observed:

1. The transformer must be located at a point as near as possible to that at which the primary wires enter the building.
2. Between these points the conductors must be heavily insulated with a coating of moisture-proof material, and, in addition, must be so covered and protected that mechanical injury to them or contact with them shall be practically impossible.
3. The primary conductors, if within a building, must be furnished with a double-pole switch, and also with an automatic double-pole cut-out where the wires enter the building, or where they leave the main line on the pole or in the conduit. These switches should, if possible, be inclosed in secure and fireproof boxes outside the building.
4. The primary conductors, when inside a building, must be kept apart at least ten inches, and at the same distance from all other conducting bodies.

SECONDARY CONDUCTORS.

The conductors from the secondary coil of the transformer to the lamps or other translating devices must be installed according to the rules for "inside wiring" for "low potential systems."

CLASS E—ELECTRIC RAILWAYS—POWER STATIONS.

All rules pertaining to arc light wires and stations shall apply, so far as practicable, to street railway power stations and their conductors.

RAILWAY SYSTEMS WITH GROUND RETURN.

Electric railway systems in which the motor cars are driven by a current from a single wire, with ground or floor return circuit, are prohibited, *except* as hereinafter provided:

1. When there is no liability of other conductors coming in contact with the trolley wire.
2. When the location of the generator is such that the ground circuit will not create a fire hazard to the property.
3. When an approved automatic circuit breaker or other device that will immediately cut off the current in case the trolley wires become grounded is introduced in each circuit as it leaves the power station. This device must be mounted on a fireproof base and be in full view of the attendant.

TROLLEY WIRES.

Trolley wires must be:

1. No smaller than No. 0 B. & S., copper, or No. 4 B. & S., silicon bronze, and must readily stand the strain put upon them when in use.
2. Well insulated from their supports, and in case of the side or double-pole construction, the supports shall also be insulated from the poles immediately outside the trolley wire.
3. Capable of being disconnected at the power house, or of being divided into sections, so that, in the case of fire on the railway route, the current may be shut off from the particular section, and not interfere with the work of the firemen in extinguishing the flames. This rule also applies to feeders.
4. Safely protected against contact with all other conductors.

CAR WIRING.

All wires in cars must be run out of reach of the passengers, and shall be insulated with a waterproof insulation.

LIGHTING AND RAILWAY POWER WIRES.

Lighting and power wires must not be permitted in the same circuit with trolley wires with a ground return, except in street railway cars, car houses and power stations. The same dynamo may be used for both purposes, provided the connection from the dynamo for each circuit shall be a double-pole switch so arranged that only one of the circuits can be in use at the same time.

CLASS F—BATTERIES.

When current for light and power is taken from primary or secondary batteries, the same general regulations must be observed as apply to such wires fed from dynamo generators developing the same difference of potential.

CLASS G—MISCELLANEOUS.

1. The wiring in any building must test free from "grounds" before the current is turned on. This test may be made with a magneto bell that will ring through a resistance of 20,000 ohms where currents of less than 250 volts are used.
2. No ground wires for lightning arresters may be attached to gas pipes within the building.
3. All conductors connecting with telephone, district messenger, burglar alarm, watch clock, electric time and other similar instruments must, if in any portion of their length they are liable to become crossed with circuits carrying currents for light or power, be provided near the point of entrance to the building with some protective device which will operate to shunt the instruments in case of a dangerous rise of potential, and will open the circuit and arrest an abnormal current flow. Any conductor normally forming an innocuous circuit may become a source of fire hazard if crossed with another conductor through which it may become charged with a relatively high pressure.

A. J. DECAMP, Chairman,
M. D. LAW,
STEPHEN E. BARTON,
WM. BROPHY,
T. CARPENTER SMITH,
} Committee Reporting to 14th Convention.

M. D. LAW, Chairman,
WM. BROPHY,
JAS. I. AYER,
WM. J. HAMMER,
A. M. YOUNG.
} Committee Reporting to 15th Convention.

THE TELEPHONE PATENTS.

By A. G. HOLCOMBE.

THE late failure of the New York Legislature to regulate telephone charges can only be accounted for by the fact that the telephone financial interest permeated the investing portion of the community to such an extent that it is considered defamatory to doubt any of the rights of this gigantic monopoly. Relief can only come by opening the gates to competition.

The method patent which has been the mainstay of the Bell Company expired on the 7th day of March last. The remaining Bell patent expires on the 30th of January, 1894. This is a combination patent, and has little force, now that it is no longer supported by the method patent; it simply covers the combination of a diaphragm capable of inductive action with a permanent magnet. A diaphragm of wood with its center connected to the armature of a magnet makes a much better receiver, and in no way infringes the Bell patent.

In regard to the Edison patent, which is supposed to cover the use of carbon in all its forms, which was recently issued, it can only be used for bulldozing purposes, and probably the twenty dollars paid for this purpose was well invested. The patent was stillborn and gives the owner no standing in court.

The patent that will require the most tact and money to extinguish is the Berliner patent, issued November 17, 1891, and, unless this is brought before the courts in an honest and sensible manner, it will give the Bell monopoly nearly sixteen years more of life. The Bell Company will undoubtedly pursue the same course which it so successfully followed to maintain the Bell patents, namely, bring a friendly suit and place the case before the court in such a light that the judge will have no alternative but to sustain the patent, and then trust to judicial courtesy to get injunctions in other courts. This Bell *vs.* Bell version is not conjecture; it was brought to light by a congressional committee, and is now a matter of record. The Berliner patent was filed June 4, 1877, and for over fourteen years the patent was in interference with the Bell Company as plaintiff and defendant, making such a pronounced case of each as to form an indelible element of prejudice.

The first claim in the patent includes everything of importance and reads as follows:

"The method of producing in a circuit electrical undulations similar in form to sound waves, by causing the sound waves to vary the pressure between the electrodes in constant contact so as to strengthen and weaken the contact, and thereby increase and diminish the resistance of the circuit."

The essential feature of this claim is comprised in the words "constant contact." Now, remembering that there is no patent on an undulatory current, or upon the use of carbon in transmitters, we will take the Reis transmitter as an example. This is an instrument that has been held by the experts for the Bell Company as an instrument the electrodes of which are not in constant contact, and substitute carbon in place of the platinum, and we have an instrument that will talk just as well as the Blake transmitter; in fact it then becomes a Blake transmitter, which does not infringe the Berliner patent, for the reason that the electrodes are not in constant contact. This can be demonstrated in a very simple manner. Arrange a hooded lamp and sheet of white paper so as to reflect a beam of light on the electrodes in such a manner as to show them in profile. Then with a camera throw an enlarged image on a white screen. As the electrodes intervene between the reflector and the camera they will appear dark on a white background.

By talking into the transmitter in a usual tone of voice it will at once be seen that the Blake transmitter is anything but a constant contact instrument, for the breaks will occur more or less with every syllable and that, too, when the instrument is adequate to do its best work. To be in constant contact the electrodes must be fixed and perpetually in contact.

In regard to the action by the Attorney-General to annul the Berliner patent there is no possibility of a termination until the patent expires from some other cause. It is simply a bunghole through which money is sucked out of the United States Treasury, and will be kept open as long as possible for the benefit of a few patent lawyers with their poor relations acting as experts at a per diem that would make a New York politician turn green with envy. It is probable, however, that the case was instigated by the Bell Company for the purpose of staving off other suits.

The object of the patent law is to encourage inven-

tion by allowing inventors to reap a just reward for their labor, and the courts will protect the inventor as far as it lies within their power to that end, but after that has been accomplished the courts cannot be expected and will not uphold doubtful patents for the purpose of supporting a monopoly against public policy, for it cannot be said that Bell and all connected with him have not had due compensation.—*Electrical Age.*

THE NEW STOCK EXCHANGE IN MADRID

A SHORT time ago H. M. the Queen Regent inaugurated the beautiful edifice erected on the Campo de la Lealtad and destined for the Stock Exchange. Representatives of the Chamber of Commerce, of Industry, of Exchange, and of Finance were present at the ceremony, which, like all such affairs that are honored by the presence of the court, was very brilliant.

From our engraving an idea can be formed of the severe and elegant exterior of the building, the work of Mr. Repulles.

The whole structure is fireproof, the materials employed being Novelda granite, brick, iron, zinc, marble, and the best of woods.

The vestibule is 65 ft. 7 in. long by 26 ft. wide, and is provided with various doors, which give access to the main exchange hall, to the wardrobe, to the hall in which official notices are posted, and to the staircase leading to the room of the Board of Brokers.

In one wing of the lower floor is the Bankers' Hall, room of the Board of Works, and other rooms destined for different purposes. On the opposite side is a cafe restaurant, a telegraph office, a telephone office, post office, and janitor's rooms.

On the main floor is the Board of Brokers' room and a hall for commercial conventions; and our attention is called to another hall above the vestibule, which is decorated with much taste and richness. But without question the most notable room in the palace is that destined for the business of the exchange. It is 106 ft. long by 65 ft. wide, and a 13 ft. gallery extends all around it. The hall is semicircular in form, and is 72 ft. high. The decoration is unusually sumptuous. The pictures on the crescent-shaped lights in the ceiling illustrate allegories of certain Spanish provinces. They were painted by the well-known artist Taberner. In the triangles formed by the arches are the coats of arms of the most important nations, and in the frieze appear the emblems of Exchange and Commerce. The upper gallery, formed by columns of red marble with capitals and bases of gilt bronze, rests on pillars of Novelda stone. The glass ceiling is arranged in artistic panels.

As lack of space prevents our giving a detailed description of the allegories, we will refer only to the decoration on the central light, which consists of a group, the figure of Peace protecting Spain and Commerce, and displaying the motto *Commercium pacem firmat.*

The building is provided with two spacious cellars, and in the attic there are rooms for the employes.

The structure covers 24,185 sq. ft. and the exchange hall more than 10,750 sq. ft. The total cost of the work is nearly $597,000, which shows that with a good administration a great deal can be accomplished with comparatively little money.—*La Ilustracion Nacional.*

PHOTOGRAPHY WITHOUT AN OBJECTIVE.

THE great advance which has taken place in the manufacture of sensitized films and the enormous increase in their sensibility to light energy has now brought photography without an objective within the sphere of practical work, and at this time it may prove interesting to note the real position of this method for obtaining photographic images.

It will be found that the present literature on the subject is very meager, and that the accounts of the experiments are so conflicting as to be unreliable.

Experimenters have found that, with large apertures, some positions of the sensitized recipient surface in the camera are better than others, and formulæ have been published, and theories have been propounded, on account of this fact.

The best known formulæ are as follows: Lord Rayleigh gives $f=(2r^2/\lambda)$, where f is the least distance of good definition, r the radius of the aperture, λ the wave length of G=0·000017 inch.

A Frenchman, Captain Colson, also derives a constant from a wave length; the constant is 0·00081 on the metric scale, and his formula, $d^2=0{\cdot}00081$ F, where d is the diameter of the aperture and F the least distance of good definition. This formula means that nine-tenths of a millimeter aperture has the least distance of good definition at one meter distance.

Mr. Dallmeyer gives the formula $b=\frac{r^2}{\lambda}$ where b is the least distance in inches for good definition, and λ the wave length G=0·000017 inch, and r the radius of the aperture.

Captain Abney gives $2\sqrt{\lambda b}$, or, in other terms, the square root of the distance from the hole, multiplied by the constant 0·008, gives the diameter in inches of the aperture which will give the best definition.

The theory propounded by both Captain Colson and Captain Abney is the same, viz., that the wave phase from the edge first meets the wave from the center of the aperture in equal phase at the focus; the misfortune is, that the formulæ based on that theory by these two gentlemen are not in accord, as the latter gives the focus about one-half that of the former.

Another view held by some experimenters is, that if with larger apertures a shorter focus be taken than the one given by their formula, then each point of the object makes an image on the recipient surface, which has the same shape as the aperture. What I have found is as follows:

1. All large apertures give soft pictures; small apertures sharp pictures, regardless of the focus employed. An aperture of one-thirtieth of an inch will give just as good a picture at thirty-two inches, at sixteen inches, at eight inches, at four inches, at two inches focus, and where disks appear in the negative they have much more to do with the illumination of the object than they have to do with the short focus, as they appear like cone shadows. An aperture of one three-hundredth of an inch will give a sharp image at any focus.

2. The photographic energy passing through an aperture is eight times greater than passes through a lens having a stop the same size as the aperture.

3. The exposure required for ordinary plates can be worked out from the datum, that where the focus is sixty-four times the diameter of the aperture the time is one second.

4. The experimental evidence is rather in favor of there being an infinite number of foci through an aperture; but, if the large apertures have distinct foci, it almost follows that the small apertures must have the same.

5. Apertures above three-sixteenths of an inch in diameter do not produce photographic images in a camera; an aperture of one-eighth of an inch appears to be in the border land between holes which will produce images and those which will not do so.

6. The distance of the object from the aperture does not appear to have any influence on the definition or the focus.

The only theory which will embrace these experiments is the supposition that when the light energy from the object grazes the edge of a suitable aperture, then the whole vibrations undergo a change of direction, because the edge of the hole becomes a new source of vibration. In other words, the infinite number of molecules on the edge of the aperture take up the vibrations, and they form new centers, from which the vibrations of the light are transmitted on to the recipient surface in the camera.

It is not difficult to imagine the result which will follow this idea. The edge of the hole for all practical purposes becomes the object, as it is imagined to be the source from which all ethereal vibrations emanate to the sensitive plate. If the longest focus could be ascertained by direct experiment, it would follow as a consequence that another focus will be found at $\frac{1}{3}$, $\frac{1}{5}$, $\frac{1}{7}$, $\frac{1}{9}$, and so on of that distance. As the number of axes of vibration are considered to be infinite, on that account the number of foci may also be considered infinite. At long distances the foci are remote one from the other, but as the distance between the plate and the aperture is approached, the foci become nearer and nearer to each other, until the point is reached where the foci follow each other so closely as to escape observation. If there is any truth in this theory, it is evident the value of this method of photography must depend on the accuracy with which the edge of the hole is drilled and upon its perfect circular form. Heretofore little care has been bestowed on apertures, and the designs of most are faulty. For example, it would be almost impossible to get a perfect image though a cylindrical or conical hole, the liability of disturbances from other surfaces or edges is too great. As our appliances for drilling holes are improved, the time may be reached when a perfectly circular aperture of one thousandth of an inch may be made, and a hole that size would become the best optical contrivance for enlargements.

The skillful use of apertures will enable artists to select any description of texture for their subjects, and the skillful use of foci any system of illuminating the field of their pictures.

To give a practical illustration of the views expressed in this paper, the writer has put in the market a quarter-plate camera fitted with two accurately drilled holes, the one aperture to give a soft picture on ordinary plates in one second, the other a sharp picture in sixteen seconds; and yet the focus is only two inches for both apertures. The result of this contrivance is that now, instead of using a magazine camera or

THE NEW EXCHANGE, MADRID, "LA BOLSA."

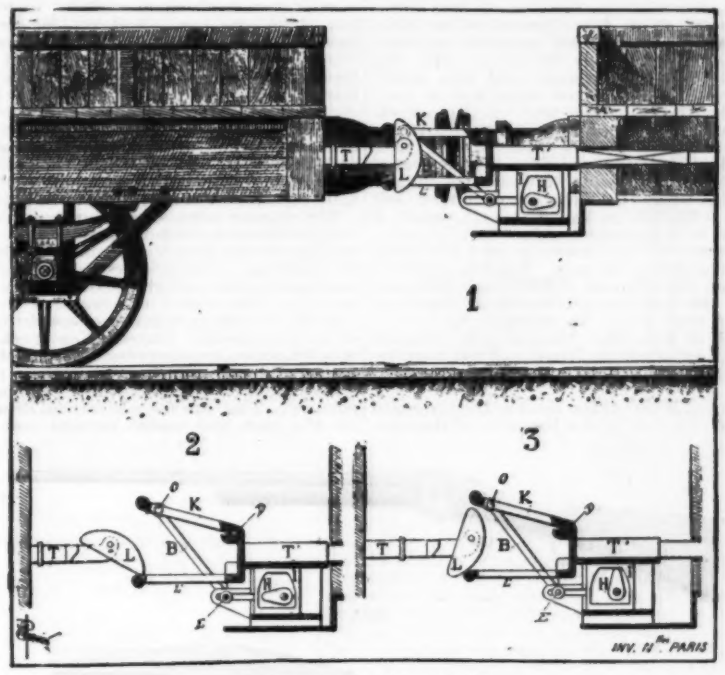
dark slides, all that has to be done is to pack six, twelve, eighteen, or twenty-four cameras into a satchel, and to use a separate camera for each picture. The cameras are so light that nine cameras only weigh two pounds, and twelve cameras pack into the ordinary satchel for a camera. There is no machinery to go wrong, and the plates are in no way disturbed until they are fit to be developed in the dark room.

The only requirement these cameras cannot yet fulfill is instantaneous pictures; the time, however, may arise when plates are so sensitive that even instantaneous images will be within the reach of cameras without an objective.—*Archd. C. Ponton, Br. Jour.*

THE PROPOSED OVERHEAD MERSEY BRIDGE.

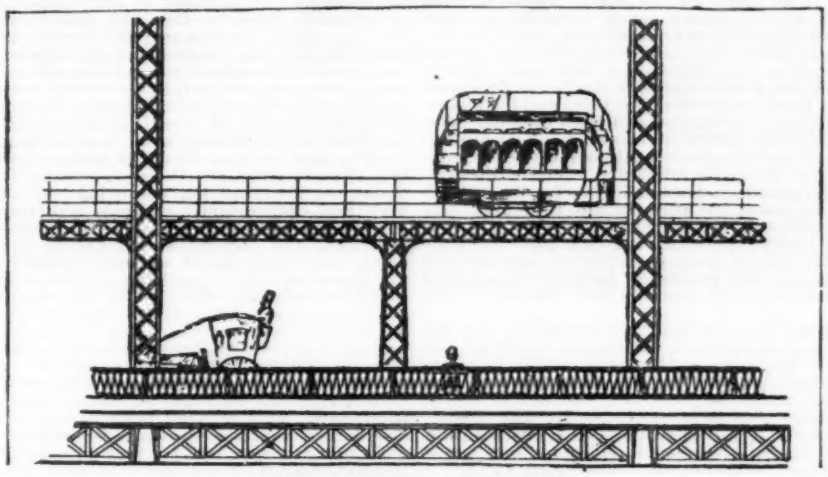
ACTING on a suggestion made some time ago by the Liverpool Chamber of Commerce that some more satisfactory means of communication between Liverpool and the docks on the opposite side of the Mersey for the conveyance of heavy traffic from ship to warehouse are highly needed, plans have recently been drawn up for a high level road bridge to cross the Mersey between St. George's Crescent on the Liverpool side and Hamilton Square on the Birkenhead side. Schemes had been set on foot for a low level bridge or a subway, but these have been condemned as unsatisfactory. The projected bridge, as proposed by Messrs. John Webster and John Wood, civil engineers, of Westminster and Liverpool respectively, would be of the arched suspension type, in three spans, the roadway being suspended from an arch instead of the usual chain, a class of bridge that is more economical in construction than any other under the existing circumstances, the conditions rendering it peculiarly applicable to the needs of the situation at Liverpool, where the fixed load is very large when compared with the moving load. In addition to being extremely rigid, it is also put forward that this type of bridge lends itself to a certain amount of architectural treatment, much more than does the ordinary girder or the cantilever bridge. Each span is to have a clear waterway of 1,100 ft., the center span having a clear headway of 150 ft. above high water of ordinary spring tides, the clear headways of the outer spans being slightly less on account of the camber of the bridge longitudinally.

Although the bridge has been designed with three equal spans, it is alternatively suggested that it may be advisable to have one large central span of say 1,500 or 1,600 ft., with two smaller side spans, to give more room for maneuvering a large ship not under absolute control. This would, however, somewhat increase the cost of the structure, and it is a matter for future consideration whether the spans should be equal or not. The main ribs of the arches consist of eight octagonal steel tubes braced together, this form being of great strength, and offering a minimum resistance to the wind; the ribs being also hinged at the springing and at the crown to prevent any abnormal strain from varying temperatures. There would be a clear headway above the high level of ordinary spring tides of 150 ft. at the center of the bridge. The bridge will allow for a clear roadway 40 ft. in width, sufficient for at least four lines of wheel traffic, and two outer footways, each 7 ft. 6 in. wide, the roadway being laid with wood and the footways with granolithic pavement. In addition to the ample provision for the ordinary wheel and passenger traffic, an overhead electric tramway would be constructed along the center of the road, supported on center columns in a similar manner to a portion of the New York overhead railway, or on girders supported by side columns. The double line of cars would run, it is proposed, to and from St. George's Crescent and Hamilton Square, and as the gauge of the line is similar to that of the Liverpool Overhead Railway, it would not be difficult to join the two systems, or in any case make them run in connection with each other. The tram cars and rails would, further, be specially designed, so as not to be overturned in the strongest gale.



A NEW CAR COUPLING.

The Liverpool approach, after leaving St. George's Crescent, would pass over the site of the buildings between James Street and Redcross Street, down to the east side of George's Dock, which it skirts until the entrance to the Floating Bridge is reached; turning then to the left, over the line of the Floating Bridge to the Liverpool abutment of the proposed bridge. It would pass over the overhead railway and over the Floating Bridge, but at such an elevation as not to interfere in any way with the traffic of either of them. The Birkenhead approach, after leaving Hamilton Square, would pass by an easy curve over various streets at an elevation sufficient for any traffic to pass under, on to the Dock Estate, over the gates between the Egerton and Morpeth Docks to the Birkenhead abutment of the proposed bridge. Sixty feet would be the clear width of the approaches, giving a roadway of 45 ft. and two footpaths of 7 ft. 6 in. each, a double line of electric tram cars being carried overhead. The approaches are to consist, it is proposed, of ornamental steel elliptical arches, of spans varying to suit each particular condition, resting on openwork steel columns of light but substantial design, the whole being surmounted by a handsome cornice and parapet railing. A large portion of the heavy or wheel traffic on both sides of the river being near the docks, as it might be inconvenient to take it up the approaches, six large hydraulic lifts, each capable of accommodating the largest lorry when loaded, are proposed to be provided in the buildings over the abutments on each side, designed and arranged for carrying the up and down traffic simultaneously.—*The Daily Graphic, London.*



PART OF SIDE ELEVATION.

A NEW CAR COUPLING.

The coupling and uncoupling of cars by means of the devices ordinarily employed requires some little time, and is quite a dangerous operation for the train hands, who are obliged to slip in between the cars before the latter have come to a standstill.

Our engraving represents a very ingenious apparatus that does away with such inconveniences by diminishing the time employed for the uncoupling, the coupling being effected automatically.

Each of the cars is provided with a rod, T (Fig. 1), called a drawbar, terminating in a metallic cap, L, capable of oscillating around an axis, *a*, fixed to *t*.

A system composed of two rectangular links, L' and K, one of which, L', is fixed to the rod, T', of the following car, and of which the other, K, is movable around an axis, D, fixed also to the rod, T', embraces the cap, L, in the way shown in Fig. 1, when the cars are connected, that is to say, when the rods that form the extremities of the links, K and L', are situated in front of the plane of the base of L.

The recession of the link, K, that must take place in order that L may enter the space between it and the link, L', is effected through a lever, B (Fig. 2), fixed to K at O, and the lower extremity of which is connected with a small piece, E, capable of moving in a slide through a frame, l, carried along by a cam H. The axis of this cam is actuated by a system of gearings and levers that can be set in motion at will.

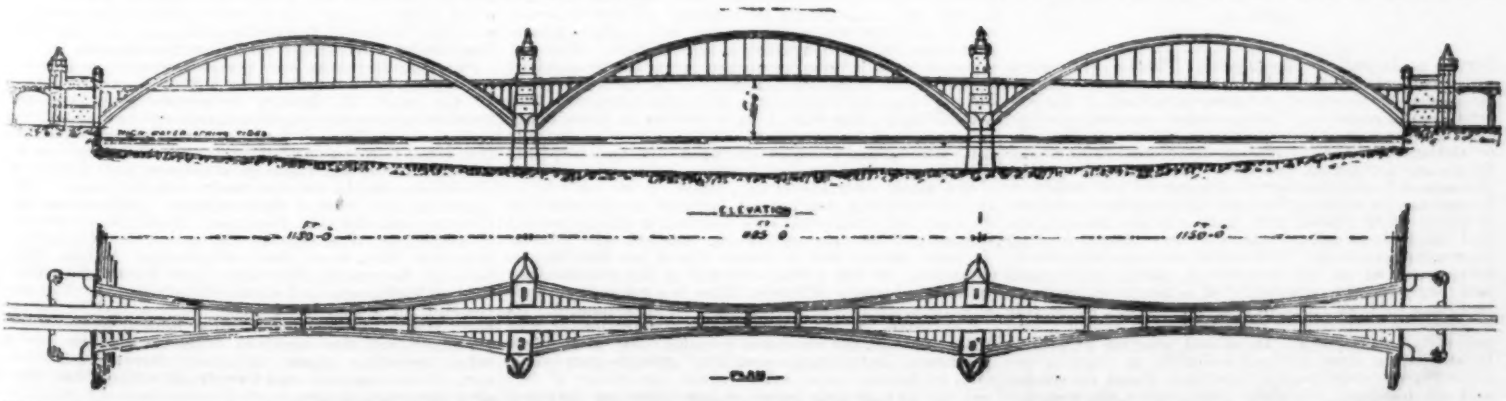
The operation of the apparatus is very simple. If it is desired to couple two cars by means of it, it will suffice to place them in juxtaposition after putting the cam, H, in the position shown in Fig. 3.

The movable head, L, abutting against the extremity of the fixed link, L', will at the same time raise the movable link, K, and enter the space between the two.

At this moment, the hood, L, as well as the link, K, will resume its primitive position under the action of its own weight.

In order to separate the cars, the cam, H, is made to take the position shown in Fig. 2, this having the effect of raising the link, K. The head, L, then having no longer any bearing point at its upper part, leaves the link, L', in taking a nearly horizontal position.

With this system, safety chains become useless. The



THE PROPOSED HIGH LEVEL BRIDGE ACROSS THE RIVER MERSEY AT LIVERPOOL.

tension of the links keeps the buffers of the cars very near each other, and this has the effect of preventing shocks, a common cause of derailments. Moreover, the maneuvers of coupling and uncoupling are effected with great rapidity.—*Les Inventions Nouvelles.*

THE GIFFARD CARBONIC ACID GAS GUN.

SOME interesting trials recently took place at Nottingham with the Giffard gun, which, *Iron* says, is the invention of Mons. Paul Giffard, whose name is well known in connection with the injector. It was introduced to the public about three years ago, but since that time it has been considerably modified in detail, although the principle remains the same. The propelling agent is liquefied carbonic acid gas, which creates neither smoke, smell, nor noise, and is completely under the control of the user. It cannot explode, and should an accident occur to the cartridge valve, it would involve nothing more serious than waste of gas. The gun and its adjuncts are illustrated below, where Fig. 1 represents the rifle, which is 3 feet 9 inches long, weighs 6 pounds when charged, and has a caliber of 0·295 inch; a smaller size, however, is made. Fig. 2 is an enlargement of the working parts, while Fig. 3 shows the gas reservoir, and Fig. 4 the method of attaching it to the gun. The rifle is of the hammerless type, and is handy in form and neat in appearance. All the parts are interchangeable and admit of repair at small cost. On reference to our engravings it will be seen that the gun is of ordinary form, fitted with an octagonal barrel and a Giffard reservoir screwed on underneath it. The action is as follows:

The movement of lowering the lever or trigger guard opens the bullet chamber for the insertion of the conical bullet, cocks the gun, moves a counter for recording the number of charges expended, and places the gun at "safe." By returning the lever to its position the bullet chamber is closed, and a movement of the thumb releases the safety catch. On pulling the trigger the tumbler strikes the firing pin, which presses against the valve of the reservoir, opening it momentarily. This permits the regulated quantity of gas to escape into the bullet chamber, where it instantly expands, forcing the projectile before it through the barrel with increasing impetus until it leaves the muzzle. The reservoir contains a sufficient supply of gas at a pressure of two tons per square inch for forty or sixty rounds, according as to whether the rifle is being used at a long or a short range. The reservoir consists of a steel cylinder closed at one end, while at the other or outlet end it is fitted with a special valve, which only permits the regulated quantity of gas to enter the bullet chamber at each pull of the trigger. These cylinders are tested up to three times the strength necessary to hold the gas under pressure, and are guaranteed to be perfectly sound and safe. The charged reservoir may be kept for any period in any climate either on the gun or detached, without suffering deterioration or waste. As already intimated, provision is made for informing the user as to the number of charges in the reservoir by means of a rotating dial which indicates by figures at every tenth round how many charges remain, the dial being set to indicate the number of charges in the reservoir at starting. This useful provision obviates all uncertainty as to the number of charges at disposal and prevents the possibility of annoyance from attempting to shoot from an empty reservoir. The rifle is specially adapted for rook or rabbit shooting, and will kill at sixty yards. In saloon practice as well as for recruits it must prove invaluable, as there is but little report, only the very slightest recoil, no smoke, and no fouling. Its other good points are accuracy and penetration, which, with the foregoing advantages, were fully demonstrated at the Nottingham trials.

FIG. 1.

FIG. 2.

FIG. 3.

FIG. 4.

THE GIFFARD CARBONIC ACID GAS GUN.

THE WATERWAYS OF OUR COUNTRY AND THEIR USE IN MILITARY OPERATIONS.

By W. T. HILDRUP HOUSE.

THE next war between the United States and any foreign power must be fought on the seas. If this be not the only scene of military operation, it will be the place for the first concerted attack. If hostilities were declared to-morrow, the enemy's navy would move immediately upon our coast cities. Hence the effectual defense of these cities should be our first thought in view of a probable naval conflict. Instead, it seems to have been our last. And yet, far-seeing statesmen have reiterated until it has almost become a proverb, "Our exposed sea frontier must be put into condition for effectual defense against the assault of any hostile fleet." How, we ask, can this be done? By utilizing our natural waterways of approach landboard, as a base of defensive operations; by removing any defects of nature in the construction of artificial supplements; and, thirdly, by making canals wholly artificial, which shall connect strategic points, and shall facilitate the transportation of troops and war supplies.

The cities on our coast have an importance more than isolated; they are the front doors of the different States, and centers not only of outland but inland commerce. The shelling of one of these cities would temporarily paralyze human activity within a very large circle of country. The critical importance of the coast cities is evidenced in the fact that they are the usual metropoli of their respective States. New York, Boston, and San Francisco are examples. The chief cause of their metropolitan development is in their position, which makes them the importing and exporting centers of the country. They are the commercial doors, which open for the vast and varied natural and manufactured products of all lands on the globe. Through them come fruits of every clime to tempt the tastes, and costly fabrics from the looms of every zone, to delight the eye of the luxurious American. Out of these same portals of trade go the creations of skill and industry which make the United States the leader in the inventions and mechanical activities of the world, while recent treaties of reciprocity pass through the same gates foodstuffs for the millions of mankind. They are also the pivotal markets for the internal traffic of each State. From all other cities and towns of the commonwealth, products grown and made for the necessities and luxuries of life pass through these great centers of distribution, from thence, and to be diffused to each of the several places for sale and use. They are the objective points of every activity and industry, and of all exchange and purchase. In them, in a general sense, is centralized the energies and interests of the State.

The destroying of a coast city would be like the killing of a commander in battle—the practical and commercial sovereign of the State would be taken away. Considering the vital importance of these cities to our entire industrial life, it is in the highest degree necessary that they be at once carefully and effectually protected. Their exposed condition is well known and continually called attention to by our wisest statesmen and military experts, yet scarcely any active steps have been taken by our government to remedy the evil, except to refer the matter to the Fortification Board, and to listen to its reports. At this time not one of our large seaport cities has any modern means of protecting itself against a hostile fleet. The old signs of coast defense are useless, being too antiquated for service in withstanding the shelling power of present heavy-armed battle ships, while the old mortars and smooth-bore rifles would be powerless in attempting to pierce their heavy armor. On the other hand, their long rifles could pound these weak defenses to pieces at a distance undisturbed by their return fire.

We stand with idle hands, thinking we yet live in the time when a monitor can be built in one hundred days or a city protected by a few field batteries behind a hastily thrown up earthwork. Should war now be declared, rudely and suddenly would our delusion be dispelled. In this advanced stage of the evolutionary progress of naval ordnance, time is a necessary requisite, no matter what money may be at command. As an example, in two weeks after a declaration of war with England, she could put into our coast cities thirty full-armed battle ships, and fifty cruisers, gun-boats, etc., on to our great lakes, where our treaty of 1817 permits us only four vessels of less than one hundred tons each, armed with one eighteen pounder. These would soon batter Chicago down around its inhabitants' ears, which no land force that we could mobilize could prevent. It is true we have torpedoes, but these are of use only when backed by shore defenses, as torpedo effects are more as a hindrance to remove while under fire than from any power of blowing vessels up. Thus the rich products of this northern frontier would prove a valuable war indemnity and at the mercy of the British fleet, for we not only have no fleet, but, as Canada owns the connecting canals, we would have no way of getting any there. To alleviate all this the remedy is plain, easy, and not expensive for a nation of our wealth. We could build canals, as I shall show later, fortify and provide effective armament, torpedoes, etc., for a few key points like Rouse's Point on Lake Champlain. Fort Wayne, on Detroit River, would debar entrance to Lake Huron, and some connecting points on the St. Lawrence River, like Ogdensburg. These few expedients would prevent the enemy from gaining access to our web-like northern frontier, while by taking one more step, that will come up later, we could put as large a fleet on the lakes as necessary.

As for our sea coast defenses, we have none, and here is where the greatest need is, for the works which exist now were designed long before modern ordnance came into use, and many have fallen into decay for lack of repair. Some of the earthworks were built in the last century, and none have gun batteries without guns and mortar batteries mortars, while the barbette guns are smooth-bores and have only carriages which expose the gunners to the fire of the enemy.

Every port on our entire coast line could be entered by the fleet which any of the four great naval powers possess, in spite of the efforts of resistance by our navy; for if the enemy was obliged to operate from home as a base of supplies, England has seventeen battle ships and seventy-two cruisers, Russia eight cruisers, Italy five battle ships and six cruisers, France fourteen cruisers. All of these carry enough coal to operate on our coast. While the same powers have one hundred and eighty other vessels capable of operating from a base on this side of the Atlantic, making about three hundred, all or part of which threaten our coast. To be sure there are a number of possibilities which menace the successful operating of large war vessels on our coast, such as ammunition supply and seaworthiness, but considering these all, they are only possibilities, and should not be given great weight.

Overshadowed by this dangerous necessity, what can we do to fortify our coast? It is true we are or soon will become the fifth naval power of the world, but to secure efficiency from our navy we must have it supplemented by capable coast defenses. For perfect defenses they are concomitant. As to the exact method of construction, experts advance many. One advanced some time ago to put our sea coast cities beyond the risk of capture, by providing for a fourfold line of defense, the outer one being of battle ships, the second of attendant gunboats and cruisers, the next of torpedoes, stationary and movable, and torpedo boats; the last a line of heavy guns mounted in turrets, casements and barbettes, together with mortar batteries, and in some places floating batteries. Gen. Wm. T. Sherman, in an article in an 1888 *North American Review*, said that the old idea of five guns afloat still existed. And all that was needed to protect our coast cities against any foreign fleet was "a few twelve inch rifles at salient points bearing on sea channels, with steel casements, an abundance of cheaper ten to fifteen inch barbette or embrasure guns with spherical cast iron shot supplemented by entanglements and torpedo system." This seems a simple and effectual defensive plan, but not so complete as proposed by the policy board of the navy, to which the matter has been referred. They have made out a careful and exhaustive plan for a navy and coast fortifications. It proposes to build ninety-two full-armed battle ships, together with thirty other armed vessels, making one hundred and twenty ships of all classes, besides one hundred and one torpedo boats, at a total cost of three hundred and fifty-five million dollars, a great sum, but in the past twenty years we have wasted one-half of that in patching up and refitting old vessels. Such a fleet with suitable coast defenses and improved waterways would make us impregnable.

Let us now see what should be done to perfect a system of coast defenses. Congress referred this to the Board on Fortifications, consisting of military experts and distinguished civilians, who made an exhaustive report in 1886. Though we have an extensive sea coast, the fortification of twenty-seven places would completely shield us, and, by securely defending eleven of them, two-thirds of all our commerce would be protected, which would virtually protect all, as the expense of fitting modern fleets would protect any but our largest cities. The Fortification Board project that for New York both the entrance to the sound and that of the ocean should be fortified by armed revolving turrets, steel-armed casements, barbette and mortar batteries, submarine mines, and torpedo boats. This requires ninety-five guns, one hundred and forty-four mortars, and will cost eight million dollars for ordnance, and fourteen million five hundred thousand dollars for defenses in which to mount them.

In San Francisco there should be similar works with one hundred and ten guns, one hundred and twenty-eight mortars, at a cost of seven million two hundred and fifty thousand dollars for ordnance, and eight million five hundred thousand dollars for defenses.

Floating batteries are needed, which would add ten million seven hundred and fifty thousand dollars to the sum. In Boston forty-three guns and one hundred and twenty-eight mortars will be needed at a cost of four million dollars for ordnance and five million seven hundred and fifty thousand dollars for defenses. These, our three great centers, well defended, the others should be less costly fortified, and might appear in the order of their urgency. Lake cities, like Chicago and Detroit; Hampton Roads, New Orleans, Philadelphia, Washington, Baltimore, Portland, Narragansett Bay, Key West, Charleston, Mobile, New London, Savannah, Galveston, New Haven, New Bedford, Wilmington, and Cumberland Sound. The entire sum for ordnance for these ports would be thirty-eight million dollars, and fifty-five million five hundred thousand and five hundred dollars for works, or a total, including mines, torpedoes, floating batteries, etc., of one hundred and twenty-six million five hundred thousand dollars.

The report of chief of engineers for 1892 says that the present project for defenses of New York Harbor at both the southern and western entrances contemplates

an armament of nineteen twelve inch guns on lifts, seventeen ten inch guns, and nine eight inch guns on disappearing carriages, one hundred and seventy-six twelve inch mortars and submarine mines, operating from five minute casements. The money for a part of these has already been appropriated. These guns will be fired over concrete and earth parapets. The mortars in use will be twelve inch caliber, of steel, firing shells weighing eight hundred to one thousand pounds. One mortar battery is already in process of construction on Sandy Hook. But since, as is claimed, such great progress is now being made in armor resistance, as for instance the Harveyizing process of our own country, that soon all attention must be given to launching explosive shells on to the decks of the enemy's ships, giving up the idea of penetrating the sides of vessels, it would be of great advantage to secure a mortar throwing high-explosive shells, which would do incalculable damage on the decks of battle ships. But all ordnance departments are in a state of such evolution that coast defenses must be planned with discretion, and the line along which we now seem to be working is that of filling our concrete parapets with mortars and twelve inch rifles, which, supplemented by torpedo systems, submarine mine stations, electric search lights, hydrophones, etc., would make an efficient barrier to any foreign power or powers.

Having once secured ourselves against invasion on our seacoast, an important adjunct to such defenses needs to be taken under consideration—the supplementing of our frontier protection by a system of internal waterways. First of all, we should develop our natural water courses, removing obstructions and deepening river and sound beds to make navigable as far as possible the strategic rivers—rivers strategic because used in mobilizing troops and transporting provisions—and building in connection with them a thorough system of ship canals, each of which would be of great commercial value, and in case of war of invaluable strategic importance.

Paramount among these, and especially on account of the Panama scandal, is the Nicaragua Canal. The idea of this canal together with Panama is as old as the discovery of the continent, but no active and thorough work was done until this century, when in 1850 and 1851 a careful survey was made, and only a few years ago the Nicaragua Maritime Canal Co. was incorporated, after having come to an understanding with Nicaragua and Costa Rica. The estimates of the total cost of the canal have been from fifty millions to ninety millions. It would be one hundred and seventy miles long, thirty miles of which is purely artificial construction, while the other one hundred and forty miles will be built by dredging, damming, etc., of the San Juan River, Lake Nicaragua and Rio Grande Valley. It is of great commercial and strategic importance, it shortens water routes to foreign commerce on an average of twelve hundred to sixteen hundred miles, while to the United States it shortens the route from eastern to western coast eight thousand miles, that gave last year over seven million tons of trade, and is as yet only in the infancy of its development.

It would not be needful for the government to subsidize, for it would be a good paying investment, which private citizens would be glad to maintain. Its strategic importance cannot be undervalued; like all such inter-ocean canals it is a key position. Its strategic potency is strongly described by Commander H. C. Taylor, in his "Control of the Pacific." The nation that controls the canals under terms of amity with Nicaragua will here find rest and refreshment for its fleets. Here may the delays of warlike complications, so injurious in sea water to the iron-hulled frigates of our time, so fatal to their speed, be easily endured without loss of efficiency; the crews growing healthier, the ships more clean-limbed and speedier in this great fresh water sea. Hence may issue squadrons in the height of vigor and discipline, striking rapid and effective blows in both oceans, and returning to refit in this sheltered stronghold, and to draw from it nourishment and fresh strength for a renewal of hostilities. There cannot be imagined a more potent factor in deciding threatened difficulties, or in securing an honorable peace with a powerful enemy, than the presence in this healthy and capacious water fortress of a strong fleet, prepared at a moment's notice to issue fully equipped from either entrance for instant service in the Atlantic or Pacific.

Another canal whose construction has but recently been agitated is one connecting the Hudson River and Lake Ontario. This canal would be of sufficient commercial importance to warrant its construction, and together with the Nicaragua Canal, it would give direct access to all the enormous commerce of the Great Lakes. This fact would answer any objection which might be made as to building a canal for strategic purposes only. The strategic importance is undeniable. It would make impossible the blockading of New York, and give us access to Lake Ontario with our great battle ships and cruisers, while our defenses at salient points on the St. Lawrence would prevent the ingress of any foreign fleet. Thus we could soon overrun Canada if the war be with England. This canal should be supplemented by a ship canal at Niagara on our side in opposition to the Welland Canal, for two reasons: First, the Welland Canal is not a ship canal, having only fourteen feet of water; and secondly, in case of war with England, the canal would be immediately closed. In conjunction with this a ship canal should be cut from Lake Erie to the Ohio, giving deep water communication with the Gulf of Mexico by way of the Mississippi, and dredging the Ohio and Mississippi would give a system of internal water communication that would effectually prevent any blockade of New York, New Orleans or lake cities.

Another system which has been time and again urged consists of four canals, one across Cape Cod, another connecting New York with Delaware Bay, a third Delaware and Chesapeake Bays, while the fourth would cut across Florida, making direct communication with the Gulf of Mexico. All these would be of immense commercial value. The Cape Cod Canal would save to the coast trade from two hundred and fifty to three hundred miles of dangerous navigation between Boston and other Atlantic cities. The New York-Delaware Canal, together with the Chesapeake Canal, would save to the Baltimore trade, of five million tonnage alone with Philadelphia and New York, two to three hundred miles, and considerable loss by dangerous coast sailing; while the Florida Canal, too, would save five to six hundred miles to all Gulf trade, and the inevitable loss by rounding the Florida capes. Thus we see that these canals are of such commercial importance that they are a necessity, and would be a gigantic step to developing our coast trade, being almost an air line route between Boston, New York, Philadelphia, Norfolk and the Carolina sounds.

Yet the four canals would be of immeasurable strategic value in case of war. Another such a system could not be developed on either hemisphere. They would permit of the rapid and easy mobilization of troops and war supplies, solving some of the base supply problems; they would effectually prevent any successful blockade of our coast cities, they would act as harbors and lines of retreat for our cruisers and privateers, they would permit of the rapid concentration of war vessels for attack or defense. All of these are vital strategic considerations, and to some extent the government has realized them, for three different surveys of the Delaware-Chesapeake route have already been made; but the full advantage of such canals seems not to have yet been appreciated by the government. Many other minor canals have been proposed, such as Duluth-Mississippi Canal, Lake Borgne Canal, Lower Michigan Canal, connecting Saugatuck and Detroit, and many others, all of which are of commercial and strategic importance. Indeed, the time will come when every maritime nation on the globe will have as a necessary adjunct to its other defenses a complete system of canals which would permit of the rapid concentration of high floating batteries at any point of danger, forming a powerful ally to its other coast defenses. The sooner our government becomes aware of it and embraces this opportunity, the sooner will the United States secure a military position among the powers of the world, and the nearer will approach the optimist's day of universal peace.

[Continued from SUPPLEMENT, No. 909, page 14528.]

THE EFFECTS OF ALLOYS ON THE MECHANICAL AND PHYSICAL PROPERTIES OF METALS.*

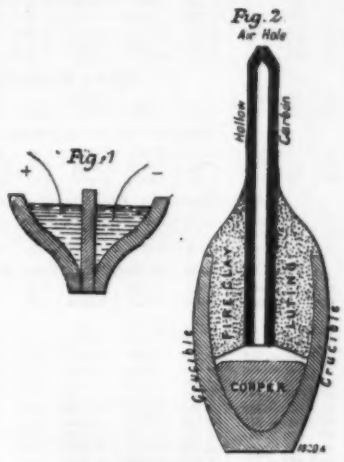
By Prof. W. C. ROBERTS-AUSTEN, C.B., F.R.S.

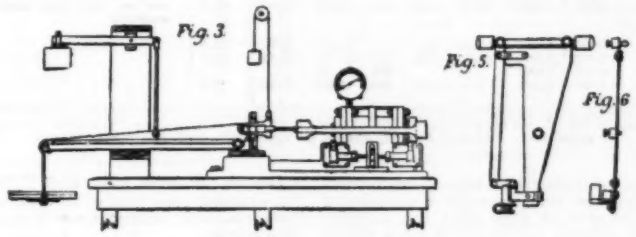
FIG. 1 is the receptacle previously referred to, and Fig. 2 the crucible.

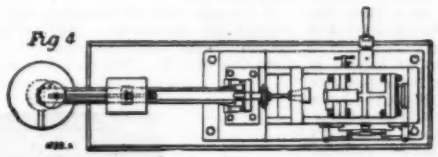
Testing Machine.—A small hydraulic machine of the single-lever type was employed, the general arrangement of which is shown in Figs. 3 and 4. The load is applied by a hydraulic ram, and measured by weights carried at the end of a bellcrank lever working upon steel knife edges. The maximum tension that could be exerted on the specimen was two tons, and the leverage was twelve times. The little appliance employed for determining the limit of elasticity is shown in Figs. 5 and 6; it consists of a frame carrying two multiplying levers, to the second of which is attached a mirror. A ray of light is allowed to fall upon this in a direction parallel to the axis of the machine, and is reflected upon a scale 50 in. distant. The frame is supported upon three hardened steel screws, two of which are sharpened and rest in slight centers punched in the test rod, being held in them by spring clips. One of these two screws, however, is connected to the frame by means of the first of the multiplying levers; and hence any elongation of the rod is greatly multiplied by the mirror. The elongation is by this means magnified to the extent of 2,000 times. The total length of each specimen was about 7 in. and the length between the jaws was 4 in.

The calculations for the strength of the rods were made both upon the original and upon the final areas which the rods assumed before fracture; but the final section was not in all cases easy to determine. The rods usually fractured in one of two ways. Either the rod broke suddenly when the case presented no difficulty, or sometimes the metal did not break until it had become drawn out to a fine knife-like edge. In the latter cases the beam of the machine dropped rapidly; and in some trials it was found that, by carefully measuring the place of stricture, and then applying again a diminished load, further extension did not occur until the load per unit of area of the constriction equaled the maximum load that had been previously applied to the rod; and that, when this load was exceeded, a further rapid constriction would occur. On account of this fact, in all cases where such rapid flow occurred, the area taken for calculation was that of the rod immediately prior to the constriction taking place. The tenacity of the worked and annealed electrotype copper, which forms the basis of the experiments, is given in curve No. 3, Fig. 7. The metal, as already stated, proved to be singularly pure.

In view of the great difficulty of obtaining large quantities of pure copper, it is not easy to see what better method could have been adopted. Nevertheless such irregularities as are shown by the respective curves







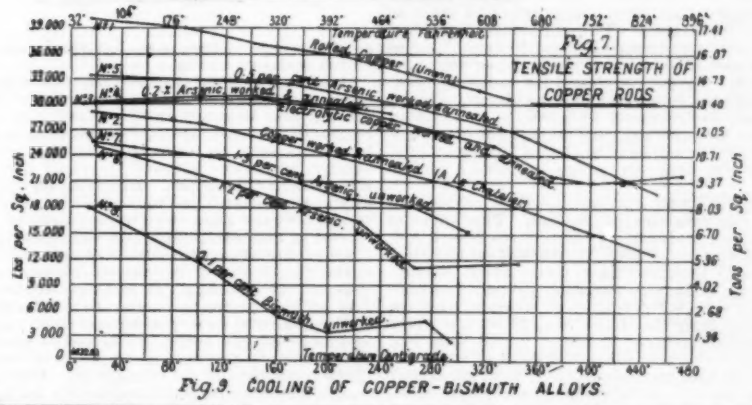
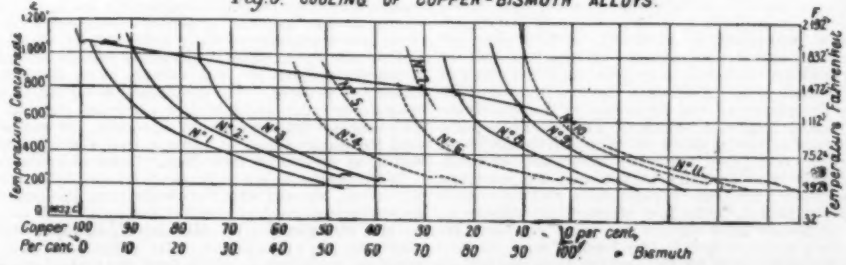


Fig. 7. TENSILE STRENGTH OF COPPER RODS
Temperature Fahrenheit
Rolled Copper (Umimp.)
0.2 per cent. Arsenic, worked & annealed
Electrolytic copper, worked and annealed
Copper worked & annealed (A. le Chatelier)
1.3 per cent. Arsenic, unworked
1.7 per cent. Arsenic, unworked
0.1 per cent. Bismuth, unworked
Temperature Centigrade
Lbs per Sq. inch
Tons per Sq. inch

Fig. 9. COOLING OF COPPER-BISMUTH ALLOYS.


Temperature Centigrade
Temperature Fahrenheit
Copper 100 90 80 70 60 50 40 30 20 10 0 per cent.
Per cent. 0 10 20 30 40 50 60 70 80 90 100 per cent.
Bismuth

* Second Report to the Alloys Research Committee, presented to the Institution of Mechanical Engineers, April 20, 1893.

TABLE I.—TENSILE TESTS OF PURE AND VARIOUSLY ALLOYED COPPER RODS SUBJECTED TO VARIOUS MECHANICAL TREATMENT.

Number of Test.	Temperature of Rod	Original Diameter.	Area of Cross Section		Coefficient of Contraction.	Load Applied.	Tensile Strength per Square Inch		Percentage of Elongation.	Description of Rods.
			Original	Final.			On Original Area.	On Final Area.		
	deg. C deg. F.	in.	sq. in.	sq. in.		lb.	lb.	lb.		
1	20 = 68	0.234	0 0430	0.0353	0.82	1069	24,840	30,250	20.0	Copper containing 1.2 per cent. arsenic. Rods tested as cast, without preliminary working. Fractures like those in set containing 1.6 per cent. arsenic (tests 39-44).
2	130 = 266	0 221	0 0384	0.0330	0.86	726	20,470	23,850	16.6	
3	224 = 435	0 216	0 0401	0 0301	0.75	620	16,460	21,850	15 0	
4	266 = 511	0 240	0.0452	0.0415	0 92	648	14,340	15,620	4 0	
5	346 = 655	0 229	0.0412	0 0327	0.79	612	14,860	18,720	10 0	
6	15 = 59	0 218	0.0373	0 0339	0 89	673	18,090	20,180	20 0	Very pure copper with 0 1 per cent. bismuth added. Rods tested as cast. All exhibited a columnar structure, in some cases developing very striking planes of fracture.
7	101 = 214	0.193	0 0292	0.0265	0 91	336	11,510	12,680	15 0	
8	162 = 324	0.195	0 0299	0 0299	1 00	168	5,620	5,620	12 0	
9	199 = 390	0.218	0 0373	0.0373	1 00	144	3,860	3,860	0 0	
10	274 = 525	0.208	0 0340	0.0333	0 98	168	4,940	5,050	0.0	
11	292 = 558	0 223	0.0390	0 0387	0.99	108	2,770	2,790	0 5	
	Effect of Working upon Rods of Pure Copper, Cast Side by Side.									
12	18 = 64	..	.	0 0208	..	1108	..	53,600	12.0	Worked. Fracture red, fibrous.
13	18 = 64	0.269	0 0568	0.0415	0.73	684	12,040	16,490	5.0	Not worked Fracture short crystalline.
	Effect of Slow and of Rapid Cooling upon Rods of Pure Copper, Cast Side by Side.									
14	18 = 64	0 246	0 0475	0.0380	0.80	876	18,450	23,050	20 0	Not worked
15	18 = 64	0 248	0 0483	0.0291	0.60	1188	24,600	40,840	7.0	Hammered, heated, and quenched.
16	18 = 64	0 270	0.0572	0.0410	0 72	1814	31,720	44,250	21 to 32	" " slowly cooled.
	Effect of Slow and of Rapid Cooling upon Rods Containing 0.2 per Cent. Arsenic, Cast Side by Side.									
17	18 = 64	0 241	0 0456	0 0299	0.65	984	21,580	32,910	20 to 40	Not worked
18	18 = 64	0 225	0 0398	0.0289	0.73	1200	30,150	41,530	30.0	Hammered, heated, and quenched.
19	18 = 64	0.218	0 0373	0.0266	0.71	1140	30,570	42,850	20.0	" " slowly cooled.
	Effect of Heating and Quenching Alone, without other Work, upon Rods of Pure Copper, Cast Side by Side.									
20	18 = 64	0.241	0.0456	0.0380	0 85	900	19,740	23,130	25.0	Tested as cast.
21	18 = 64	0 238	0.0445	0 0235	0.53	914	20,540	38,900	21 to 42	Tested after having been heated and quenched three times in succession.
22	11 = 52	0.210	0.0346	0.0211	0.61	1044	30,170	49,490	37 0	This set of rods was made from copper of a high degree of purity. They were hammered, rolled, and slowly annealed. All gave fibrous fractures, passing into granular as the temperature of the test increased.
23	15 = 59	0.197	0.0304	0.0130	0 43	900	29,600	69,200	27.0	
24	100 = 212	0.205	0.0330	0.0183	0.56	1020	30,920	56,040	30.0	
25	102 = 216	0.210	0.0346	0 0204	0.59	984	28,450	48,240	30.0	
26	151 = 304	0.209	0.0343	0.0235	0.68	1032	30,090	43,930	23.0	
27	218 = 424	0.187	0.0275	0.0133	0.48	798	29,020	60,000	25.0	
28	249 = 480	0.206	0.0340	0.0196	0.58	960	28,240	48,490	37.0	
29	335 = 617	0.188	0.0277	0.0149	0.54	708	25,540	47,130	21.0	
30	370 = 693	0 195	0 0299	0.0165	0.55	630	21,070	38,180	20.0	
31	401 = 754	0.190	0.0283	0.0196	0.70	604	20,900	30,000	15.0	
32	470 = 878	0.180	0.0254	0.0238	0.94	552	21,730	23,190		
33	18 = 64	0.225	0.0398	0.0289	0.72	1200	30,150	41,530	30.0	Copper containing 0.2 per cent. arsenic. Rods cast as described on page 10, and carefully worked and annealed like Nos. 22 to 32.
34	108 = 214	0.210	0.0346	0.0201	0.58	1068	30,880	53,140	30.0	
35	144 = 291	0.200	0.0314	0.0218	0.69	972	30,960	44,590	21.0	
36	249 = 480	0.205	0.0330	0.0188	0.57	948	28,730	50,470	30.0	
37	18 = 64	0 246	0.0475	0.0360	0.81	876	18,450	23,050	30.0	Rods of very pure copper, tested as cast, without preliminary working.
38	18 = 64	0.241	0.0456	0.0380	0.83	900	19,740	23,140	35.0	
39	15 = 59	0.230	0.0447	0.0314	0.70	1140	25,460	36,270	25.0[1]	Copper containing 1.5 per cent. arsenic. Rods tested as cast, without preliminary working. Fractures finely drawn at low temperature, and coarsely granular at high ones; and paler in colour than those of pure copper.
40	18 = 64	0.225	0.0897	0.0296	0.74	1008	25,400	34,170	25 to 30	
41	116 = 241	0.212	0.0353	0.0283	..	928	23,480	29,260	26.0	
42	215 = 419	0.230	0.0415	0.0290	0.72	807	19,450	27,000	37.0	
43	260 = 500	0.230	0.0415	0.0214	0.51	761	18,360	35,610	irregular	
44	308 = 586	0.230	0.0415	0.0415	1.00	824	19,860	19,840	0.0	
45	15 = 59	0.212	0.0353	0.0283	0.80	762	21,580	26,930	13.0[2]	Copper containing 0.2 per cent. tellurium.
46	15 = 59	0.215	0.0363	0.0211	0.58	840	23,140	39,920	considerable	
47	15 = 59	0 230	0.0491	0.0430	0 87	840	17,110	19,540	13.0	Copper containing less than 0.05 per cent. potassium, tested as cast.
48	15 = 59	0.235	0.0398	0.0308	0 77	916	23,070	29,740	11.0	Copper containing less than 0.05 per cent. potassium, rolled and annealed.
49	18 = 64	0.217	0.0370	0.0161	0.43	1236	33,420	74,900	37 0[3]	Rods of very pure copper contaminated with 0.5 per cent. arsenic. These were all cast in one set, and very carefully worked and annealed.
50	100 = 212	0.205	0.0330	..	..	1020	30,920	..	30.0	
51	170 = 338	0.211	0.0350	0.0170	0 48	1030	29,150	60,000	35.0	
52	170 = 338	0.215	0.0363	0.0130	0.33	1178	32,470	84,740	30.0	
53	258 = 496	0.212	0.0356	0.0154	0.43	1068	30,020	69,350	23.0	
54	340 = 644	0 206	0.0333	..	..	900	27,030	..		
55	446 = 835	0.205	0.0330	0 0277	0.84	600	20,000	23,230	13.0	

[1] Limit of elasticity 2,600 lb. per square inch. [2] Limit of elasticity 4,260 lb. per square inch. [3] Limit of elasticity 1,193 lb. per square inch. [4] Limit of elasticity 3,940 lb. per square inch, confirmed by a second test.

plotted in Fig. 7 are probably due less to variations in the duration of the test than to want of uniformity either in the amount of work done upon the samples tested or in the annealing to which the test pieces were subjected. This is shown by the fact that the coefficients of contraction, found by dividing the area of the fractured surface of the test piece by its initial area, while they vary, as do those given by André le Chatelier, from 0·43 to 0·94, do not show the same uniform and progressive rise with the temperature of the experiment. The metal appears to be quite as ductile at the ordinary temperature as the samples tested by M. Le Chatelier, whichtends to show that the annealing to which they had been subjected had been as complete as in his samples. The copper as cast, when tested at the ordinary temperature of 18 deg. C., or 64 deg. Fah., showed a tenacity of 18,410 lb., or 8·219 tons per square inch. Copper employed for industrial purposes is worked and annealed; and, as already stated, this might raise the tenacity to 41,000 lb., or 18·3 tons per square inch and upward, and no amount of annealing would reduce the tenacity to that of the cast metal. The results of the tests are given in Table I. and in Fig. 7.

Arsenic, Bismuth and Antimony.—First as regards the effects of the presence of arsenic. The effect of arsenic on copper is shown by the curves Nos. 4, 5, 6, 7, in Fig. 7. Nos. 6 and 7 were not worked; if they had been, they would probably have come much higher. A series of four rods was carefully prepared of pure copper alloyed with 0·2 per cent. of arsenic, and the results obtained from the tests (Nos. 33-36) are given in Table I., and are plotted in the curve No. 4, in Fig. 7. The tenacity of pure copper at 300 deg. C., or 570 deg. Fah., is 9·38 tons per square inch, with an elongation of 34·6 per cent. (A. Le Chatelier); while that of the arsenical copper, according to the results of the experiments now published, is 28,230 lb., or 12·6 tons per square inch at that temperature. It appears safe to conclude that the superior strength and ductility of arsenical copper is maintained at the temperatures attained by the plates of the fireboxes of locomotives; and it is harder than pure copper. This would explain the preference of the makers of locomotive fireboxes for old brands of copper, supplied before the elimination of arsenic was so fully understood by smelters. This is borne out by some experiments recently made by Professor Hampe,* who has studied the effects of arsenic, antimony and silicon on pure copper. He employs very pure copper in the form of wire, having an initial tenacity of 49,120 lb., or 21·93 tons per square inch, and shows that the effect of the presence of 0·351 per cent. of arsenic is to raise its strength to 72,380 lb., or 32·26 tons; while with a larger proportion, 0·808 per cent. of arsenic, the strength is somewhat less, namely, 69,380 lb., or 29·7 tons. The influence of antimony appears to be even more marked, the strength of copper with 0·26 and 0·529 per cent. being respectively 73,800 lb., or 32·96 tons, and 77,900 lb., or 34·77 tons. No attempt was made to ascertain the strength of these alloys at temperatures higher than those of the atmosphere.

A curious form of fracture was presented by the rods containing bismuth. All exhibited a more or less quasi-fibrous fracture, and rather suggested that of a network of cells; but in a few cases a very fine surface

Fig 8

as of cleavage planes was the result, an example of which is shown in Fig. 8.

Questions of great interest are raised by the curves given in Fig. 7, which represent the influence of arsenic and bismuth on the tenacity of copper. The results of Professor Hampe's experiments, just referred to, would seem to show that antimony behaves like arsenic, and when present in small quantity greatly strengthens the copper. Bismuth, on the other hand, as the experiments submitted to the committee show, renders copper singularly weak; and the peculiar behavior of bismuth pointed to the necessity for a very close examination of its mode of action. For instance, curve No. 8, Fig. 7, represents copper containing 0·1 per cent. of bismuth. It was too brittle to work, and has at the ordinary temperature a tenacity of 18,000 lb., or about 8 tons per square inch; and when the members of the series are tested at graduated rising temperatures, the fall in tenacity is very rapid, and there is practically no elongation. The effect of bismuth, however, does not appear to be quite proportional to the amount present, as copper with 0·2 per cent. has a tenacity of only 7,000 lb., or about 3 tons per square inch. The prejudicial effects of bismuth, it would appear, do not vanish, even though but a trace be present. For instance, curve No. 3 is from singularly pure copper, but analysis showed it still to contain 0·002 per cent. of bismuth. It worked well, and the entire series is strong, but the elongation is small, as shown by tests Nos. 12 and 14 in Table I.

Why bismuth, when present in amounts above 0·1 per cent., should differ so widely in its action from arsenic and antimony is not at first apparent. According to the classification of Mendeleef, arsenic, antimony and bismuth all belong to the same family, of which nitrogen is the type. It is true that the atomic volume of bismuth 30·9 is higher than that of arsenic 13·2, or of antimony 17·9; and therefore, according to the principle I have laid down, it ought to diminish the tenacity of copper, of which the atomic volume is only 7·1; but then the influence of arsenic and antimony should be exerted in the same direction as bismuth, though in a less degree. It soon became evident that a complex and tedious series of experiments could alone afford hope that the peculiar action of bismuth would be explained; and it was clear that the method detailed in the previous report was the one to follow in the attempt to determine what happens during the solidification of copper containing bismuth. A comprehensive series of alloys was prepared, and each member of the series was analyzed in the metallurgical laboratory of the Royal College of Science; and the results will be given subsequently. Each alloy was melted, and the thermopile, protected by a very thin tube of fire-clay, was inserted in the molten mass, and its behavior during cooling was studied by the aid of the autographic method of registration. The results of these experiments, which have extended over nearly a year, are shown in Fig. 9, and reveal a wholly unexpected fact in connection with the action of bismuth on copper. On the left of the diagram will be found the time temperature curve of the cooling of the purest copper which could be obtained. This is also shown in Fig. 9 in the *facsimiles* of the photographs actually obtained. It will be observed that the portion of the curve which represents the evolution of the latest heat of fusion is closely horizontal, and the angles are comparatively sharp. In general this is an indication of the purity of the metal under examination. An incidental point of interest deserves mention: there is a slight depression at the extreme left, which shows that *surfusion* took place, the copper having passed below the freezing point before it actually became solid. The rest of the curves show the gradual fall in the solidifying point of the copper produced by the addition of increasing amounts of bismuth. The curves, numbered 2 to 10 on the diagram, have also the temperatures as ordinates and the times as abscissæ; but each curve has been arranged diagrammatically at such a distance from its neighbor that the abscissa of its higher initial point of solidification represents the percentage of bismuth it contains. Consequently the red mean curve drawn between these higher solidifying points will represent the curve of temperature of solidification of the entire series.

It will be observed that each curve representing the cooling of a copper-bismuth alloy has a second or lower point of solidification upon it, and that this lower point occurs at a constant temperature in each, very close to the melting point of bismuth itself; consequently a line drawn through these lower points is approximately horizontal. The existence of a second point of solidification is evident even when the copper contains only 1 per cent. of bismuth; and this fact goes far to explain the peculiar action of bismuth upon copper. It would appear that, however poor or however rich in bismuth the alloy with copper may be, a portion of bismuth, containing perhaps a little copper, always remains fluid until the temperature of the mass has fallen to 268 deg. C., or 514 deg. Fah., the point at which bismuth itself solidifies. The presence of a fluid constituent in an alloy, long after the mass itself has become solid, is doubtless the determining cause which enables the metal to assume a highly crystalline and consequently an intensely brittle structure. So far as the author knows, the cause of the peculiar behavior of bismuth could not have been revealed by any other method of investigation than the one adopted, which is a direct outcome of the work of the committee, and of which an account was published for the first time in the previous report.

Judging from their polished surfaces, the alloys of copper rich in bismuth are, to all appearance, as coherent as the alloys of copper and tin, which possess great strength and have such wide industrial application, as "gun-metal" and "bell-metal," for instance. Bell-metal contains 75 per cent. copper and 25 per cent. tin; replace the tin by bismuth and an apparently coherent alloy is produced. It is not sonorous, however, and has but little tensile strength; and the persistence with which a portion of the alloy remained fluid while the mass was cooling doubtless explains this weakness. On solidification nearly all the series of alloys reject a small portion of a very fluid alloy, which is squeezed to the surface, and may often be detached as a little button. This fact explains a certain want of regularity in the curves, Nos. 3 and 6, for instance, as the analyses of the alloys were made after the cooling curves had been taken, and some portion of this rejected part of the alloy may, in a few instances, have been lost; and a small source of error has thus been introduced, which was not recognized until the work was far advanced. Analysis proved that these detachable buttons consist of bismuth containing 0·10 per cent. of copper; a fact which is entirely in accordance with the recent observation of Heycock and Neville,* who have shown that bismuth is soon saturated with copper, as little as 0·4 per cent. of copper being sufficient to effect this, while as much as 1·0 per cent. of other added metals is required to effect the moleular saturation of copper.

Before leaving the consideration of the effects of impurities, so far as they have as yet been examined, it may be well to refer to the analysis of a sample of copper given in the appendix.

The metal was taken from a locomotive firebox which possessed singular endurance. The engine had been running for twenty years, and had covered 500,000 miles. Analysis proves it to be very impure, notwithstanding the fact that in specifications for the metal of which fireboxes are constructed it is usual to direct that it shall not contain more than 0·5 per cent. of impurity. This sample contains as much as 1·3 per cent. of impurities, of which 0·4 is lead, 0·37 arsenic and 0·3 nickel. At present no satisfactory explanation can be given of the singular qualities of this sample of copper; but the work of André Chatelier† has shown that at 400 deg. C., or 750 deg. Fah., a temperature which is readily attained in fireboxes of locomotives, pure copper is singularly liable to disruption. Its very ductility is a source of danger, for even the deformation produced by successive expansions and contractions will destroy it. The effect of the presence of small quantities of foreign elements, such as aluminum or nickel, increases the endurance of the metal by rendering it less ductile. The case in point is a remarkable one, and serves to show how very complicated the question becomes when various impurities act on a metallic mass in presence of one another.

Influence of Impurities on Annealing.—Experiments

* *Chemiker Zeitung*, May 25, 1893, page 726.

* Journal of the Chemical Society, 1892, vol. lxi., page 888.

† Le Genie Civil, 1891.

are in progress with a view to ascertain in what order impurities hinder the restoration to copper of its original strength and ductility, after it has been strained beyond the limit of elasticity.

Effect of Pressure.—The passage of iron from one allotropic modification to another is accompanied not only by a change of heat capacity, but also by a change of volume. When a mass of iron cools down from a temperature of 1,000 deg. Cent., or 1,800 deg. Fahr., it also contracts, until at the point of recalescence it suddenly expands; after which it again contracts, as it cools to atmospheric temperature. An experiment described in the previous report (*Engineering*, vol. lii., pages 548 and 579) indicated the probability that pressure lowers the critical points of iron and steel. Osmond* specially refers to this experiment, which, he says, is the first and only one as yet made that appears to indicate the influence of pressure on the position of the critical points. The effect of pressure, he suggests, is analogous to that established by MM. Mallard and H. Le Chatelier,† who showed that pressure lowers the point of transformation of iodide of silver from 146 deg. Cent., or 295 deg. Fahr., to the ordinary temperature of 15 deg. Cent., or 60 deg. Fahr.

By compressing a piece of steel in a hydraulic press it should be possible to obtain recalescence at a lower temperature than would be the case if the pressure were not applied. Observations were made by the eye in order to see whether such a lowering of the recalescence point could be detected in a piece of compressed steel; but it was found that lateral flow of the test piece rendered the experiment difficult by preventing the application of a sufficient stress until after the metal had passed through its allotropic change, and had become more or less rigid. Moreover, the orifice in which the thermo-junction was placed in the specimen became obliterated by the lateral flow of the metal. One such experiment, however, is given. A cylindrical piece of steel 1 in. long and ¾ in. in diameter was bored through two-thirds of its length with an axial hole ⅛ in. diameter. A thermo-junction was carefully prepared by wrapping long fibers of asbestos round the two wires forming it, so as to insulate them from each other; and the junction so prepared was allowed to protrude from the face of one of the two dies by which the pressure was applied, so as to enter the hole in the block of steel. It is obviously necessary to insert the junction in a hole whose axis is parallel to the direction in which the pressure is applied; otherwise the deformation which takes place would compress the thermo-junction. The mass was heated to 1,000 deg. Cent., or 1,800 deg. Fahr.; and it was found that without the application of pressure the recalescence occurred at 650 deg. Cent., or 1,200 deg. Fahr.; and that when a total load was applied of 4 tons, equivalent to 9 tons per square inch, recalescence occurred at 620 deg. Cent., or 1,150 deg. Fahr., and was comparatively feeble.

This experiment proved to be difficult to repeat, and a closed or recessed die was therefore made of steel, in which pressure could be applied all round the test piece in a way that was not possible in the previous experiment. The die consisted of a heavy steel collar 2½ in. external and ⅝ in. internal diameter. One end was closed by a short hardened plug of steel, and the opposite end was provided with another and longer plug, through which an axial hole had been made for the insertion of the thermo-junction. The specimen was heated in connection with a separate thermo-pile, until the required temperature of 1,000 deg. Cent., or 1,800 deg. Fahr., was attained; it was then transferred to the die, and pressure was quickly applied. A marked lowering of the recalescence point was observed; but the experiment was open to objection that, on account of the more intimate contact between the die and the steel specimen when the latter was put under pressure, the rate of cooling was greatly increased. A much larger die was therefore prepared, of which a dimensioned sketch is given (Fig. 10), and each block of steel, S, was carefully wrapped in an asbestos covering before it was heated, thus insuring a hot, sound, non-conducting coating to the specimen at the commencement of the experiment. At the same time an autographic record was taken of the temperature. The thermo-junction was not calibrated, but pairs of autographs were taken, one without any pressure being applied to the specimen and with the normal rate of cooling, and then one with the die under pressure. A single block of steel was also employed in order to obtain a set of four curves, by which to show the effect of water hardening and of oil hardening. Three sets of experiments in all were made (Fig. 11), and four typical curves are given. From a study of these it will be evident that the recalescence point is lowered by pressure; but it was found that this lowering is not effected unless the load is applied at a temperature well above that at which recalescence takes place.

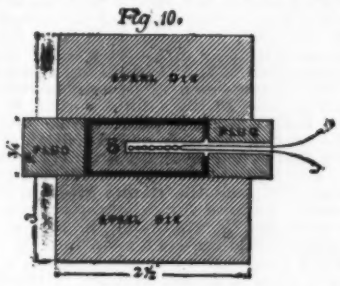
Bismuth, Lead, Tin.—It has long been known‡ that when a triple alloy of bismuth, lead, and tin, which bears Newton's name, is cooled down from the molten state, there occurs, long after the metallic mass has solidified, a remarkable rise in its temperature. Experiments made in view of the present report show that this evolution of heat occurs generally at 46 deg. Cent. or 115 deg. Fahr. An evolution of heat also takes place if the solid mass is cooled rapidly by quenching in water. This effect, however, disappears after the third or fourth heating, but may be restored by remelting the mass or by raising it to a temperature just below its melting point. A suitable alloy for the experiment is the one containing 50 per cent. bismuth, 31¼ per cent. lead, and 18¾ per cent. tin. The appearance of the fractured surface of the mass, if broken before the evolution of heat, is plate-like, crystalline, and almost vitreous; but after the thermal change the fracture is gray, dull, and finely grained. It will be evident that the changes this alloy undergoes present certain analogies to those which take place in steel during the hardening by rapid cooling from a high temperature, and when the metal cools slowly from bright redness. In the latter case, if low-carbon steel be the subject of the experiment, there are, as has already been pointed out in the previous report, at least two distinct evolutions of heat; one at 855 deg. Cent. or 1,571 deg. Fahr., due, it is believed, to a molecular change in the iron; and the other at 655 deg. Cent. or 1,211 deg. Fahr., arising from a change in the relation between the carbon and the iron. The alloy now under consideration contains three constituents; and the change which is made evident by evolution of heat must clearly be due either to a change in the mutual relations of the constituent metals or else to polymerization or redistribution of the atoms in the molecules of the solid mass, either of which changes is attended with the evolution of heat. That molecular modification does take place in these alloys during cooling has been shown by E. Wiedemann* and by Spring.† In steel, carbon is present, and complicates the problem under examination, which is not the case with the triple alloy: but in the latter it is possible that one of its constituent metals may play a part analogous to that of carbon.

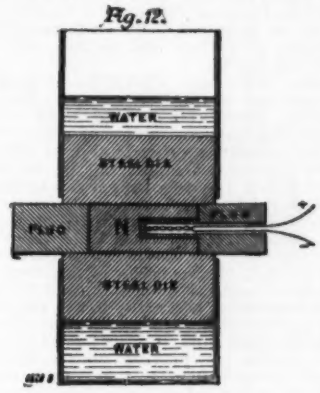
A careful study was therefore made of the behavior of the alloy, and it may be well to publish the results in full at some future time; at present it is only necessary to summarize the conclusions to which the investigation appears to lead. The question arises, Is the quenched Newton's metal the analogue of hardened steel? First, as regards change of volume, Ermann and afterward Kopp found that the expansion of similar alloys is abnormal. The present experiments show that the change from the vitreous variety of the alloy to the finely crystalline is accompanied by an expansion of about 0·8 per cent. Steel also expands during the operation of hardening. The tenacity of the alloy in the vitreous state is very low, only about 1 ton per square inch; but after the molecular change a maximum of 2¼ tons per square inch is attained, the effect being the same whether the change has taken place spontaneously or has been induced by rapidly cooling the alloy. Annealing the bars at a temperature of 80 deg. Cent. to 90 deg. Cent., or 176 deg. Fahr. to 194 deg. Fahr., after the molecular change has taken place, appears slightly to increase their strength. The alloy solidifies at or about the temperature of 96 deg. Cent. or 205 deg. Fahr., with a range of pastiness extending over several degrees, which prevents any mechanical measurements from being made until the mass has cooled to about 92 deg. Cent. or 198 deg. Fahr. Throughout the range of temperature between 92 deg. Cent. and 80 deg. Cent. or 198 deg. Fahr. and 176 deg. Fahr., it contracts at an average rate of 0·000144 of its length per degree Centigrade or 0·000080 per degree Fahrenheit; and the contraction continues, but in gradually decreasing amount, until at 49 deg. Cent. or 120 deg. Fahr. it ceases, and the metal commences to expand. The amount of the expansion is considerable, over 1 per cent. of its linear dimensions; and appears to be due to some process resembling that of combination, for it requires an appreciable amount of time for its complete development, and is accompanied by a considerable evolution of heat. If, on the other hand, the alloy be cooled too slowly, the evolution of heat is not well marked. The converse phenomenon of contraction with absorption of heat, noticed upon reheating the alloy, does not occur at the expected temperature, but at a higher; and the fact that the change is thus not truly reversible supports the view that the molecular change in the alloy is due, as is doubtless the case in steel, to combination and dissociation occurring in the solid mass.

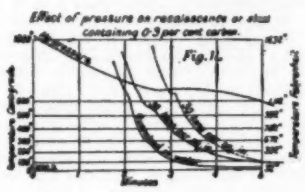
Under these circumstances it became interesting to see whether the application of pressure would cause the change to take place at a lower temperature than that at which it would occur without pressure. A steel die was formed with a surrounding water jacket (Fig. 12). The plug of the die had a steel socket, in which the thermo-junction was inserted, so that the pressure did not come upon it in any way. This was found to be necessary, as otherwise the insulation failed, and the metal was "squirted" along the wires, causing a short circuit. The alloy, N, was poured into the cavity of the die, which had previously been lined with several folds of paper; the die was closed and placed in the press, and then heated until the metal again became fluid. A steady stream of cold water was then run through the water jacket, and by the aid of a thermo-junction, inserted in the socket before mentioned, an autographic record of the temperature was taken, while pressure was steadily applied to the die. It had previously been found that the abnormal rise in temperature in the absence of pressure was coincident with the expansion of mass. The result of the experiment showed that under a pressure of 1 ton per square inch the temperature at which the thermal change took place was lowered as much as 4 deg. Cent. or 7 deg. Fahr., and that a pressure of about 4 tons per square inch was sufficient to obliterate the thermal disturbance altogether. It is interesting thus to see that, where the pressure is sufficient to cause the particles of the mass to assume the quasi-fluid state, the changes are so greatly modified (Fig. 13).

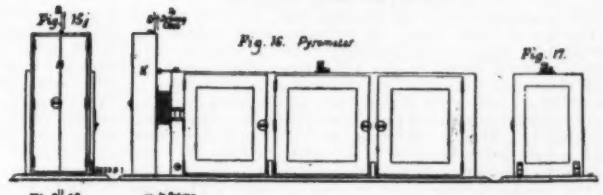
The effect of pressure in lowering the critical point in this alloy is evident; and it was interesting to ascertain whether the compression of the mass had really prevented the alloy from undergoing the molecular change from the vitreous to the gray variety; or whether recalescence had been so gradual that there was no sudden augmentation of temperature in the cooling mass, such as would be indicated by a marked discontinuity in the autographic curve. The die was accordingly made in halves, so that it could be rapidly opened when the pressure was released. The solid cylinder of compressed alloy was removed and fractured with as little delay as possible; but it was found that the change, though not complete, was far advanced. It is impossible to say whether the change occurs directly the pressure is removed or during the time it has been applied.

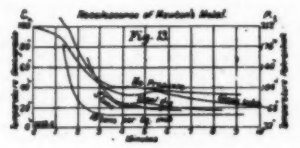
Chromium Steel.—The question of the shifting of the temperature at which the molecular changes in iron and steel take place is one of much importance. Osmond has already shown that, if the initial temperature to which a mass of carbon steel is raised be a high one, the critical points may occur at temperatures which are many degrees lower than those at which they occur when the steel is heated to the usual initial temperature of about 900 deg. Cent. or 1,650 deg. Fahr. adopted in these experiments. Very interesting results were obtained with some specimens of chromium steel supplied by Mr. Hadfield. The sample most used was one containing the following percentages: chromium 15·12, carbon 1·79, silicon 0·61, sulphur 0·08, phosphorus 0·04, manganese 0·28 per cent.; and the first autographic curve obtained from it failed to show any but the slightest indication of molecular change, which occurred at the elevated temperature of 840 deg. Cent. or 1,534 deg. Fahr., the piece of metal having been heated to 1,270 deg. Cent. or 2,318 deg. Fahr., and slowly cooled. The experiment was repeated, the heating being continued to the still higher temperature of 1,295 deg. Cent. or 2,363 deg. Fahr., with the result that no molecular change at all could be detected. It was ultimately found that the recalescence occurred only when the metal had been moderately heated, or else when it

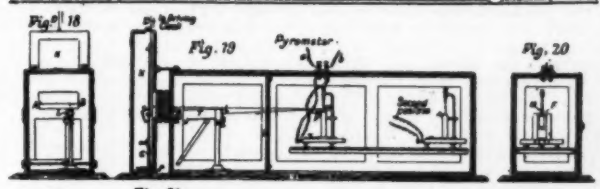


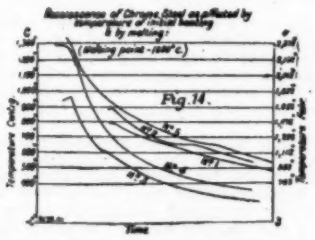


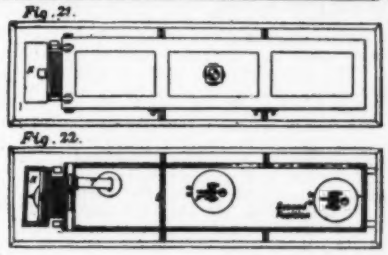












* Rapport sur les Essais de Trempe. Commission des methodes d'essais des materiaux des construction, Section A.

† Comptes Rendus, vol. xcix., 1884, page 137.

‡ Ditte, Legons sur les Metaux, 1891, Part I., page 21.

* Wiedemann's Annalen, vol. iii., 1878, p. 237.

† Bulletin de l'Academie Royale de Belgique, vol. ii., 1886.

was cooling down from the fused state; and that heating the cold metal up to an intermediate temperature of 1,900 deg. Cent. or 2,370 deg. Fahr. caused the evidence of molecular change to disappear when the mass cooled. When the temperature of initial heating was 850 deg. Cent. or 1,560 deg. Fahr., instead of being 1,280 deg. Cent. or 2,336 deg. Fahr., it was found that the temperature of true recalescence shifted from the normal point, 655 deg. Cent. or 1,211 deg. Fahr., down to 620 deg. Cent. or 1,148 deg. Fahr., and in the latter case it was difficult to detect. These results are shown in Fig. 14. The behavior of the chromium steel is therefore similar to that of carbon steel: but the shifting of the points of recalescence is much exaggerated in degree, the remarkable fact being that fusion restores the power possessed by the steel of undergoing molecular change. These facts were observed quite independently by Osmond and by the author. The explanation of them would appear to be closely connected with the solution in the mass of metal of a hard compound of chromium, carbon, and iron, the solubility of the compound varying with the temperature to which the mass has been raised. Osmond is perfectly justified in considering that in the absence of carbon the presence of chromium does not maintain the iron in the β or hard condition. We know too little as yet about the chromium steels to enable wide generalizations to be made. It is important, however, to note that the atomic volume of chromium is nearly the same as that of iron, and its influence ought not to be great. It is to be hoped that the use of the electrical furnace which has now been provided for the purpose of this investigation will enable a quantity of pure chromium to be prepared.* The relations of this interesting metal to carbon and to iron may then be studied with advantage.

Autographic Recording Pyrometer.—This instrument was described in the first report to the committee; but as the investigations progressed it soon became evident that the construction of many of the details could be greatly improved; and, in order that a more perfect instrument might not be wanting, the appliance of which the following is a description was made at the Royal Mint by artificers from the Royal Arsenal, Woolwich, who were permitted by Dr. Anderson, director-general of ordnance factories, to undertake its construction for use in his department. As shown in Figs. 15 to 22, it consists of a camera about 5 ft. long, in which the galvanometer may be placed in either of two positions, according to the range of temperature to be observed. This camera has three doors, and is made separate from the portion of the apparatus which contains the moving photographic plate. The two parts are connected by a flexible leather "bellows" junction, J, the object being to enable the plane of the sensitized plate to be adjusted at right angles to the ray of light from the galvanometer mirror, M. Inside the camera is a focusing tube, T, containing a lens, L, which receives the light from the mirror, H, and transmits it to the galvanometer mirrors, F and M. Of these mirrors M is movable, and is carried by the coil of the galvanometer; while F is carried upon an adjustable arm fixed to the supports of that instrument, its function being to send a ray of light from the mirror, H, to the slit, A B, and thus to trace a datum line as the photographic plate travels upward. The temperature is recorded, as described in the last report, by the variations in the position of the spot of light derived from the mirror, M. There is a screen, S, to cut off light reflected from the brasswork of the galvanometer. The end of the tube, T, is provided with an adjustable brass slit, by means of which the width of the photographic traces on the plate can be varied. The mirror, H, is mounted on a block, which can be adjusted so that external light may be brought from either side. The focusing of the lens, L, may be effected from outside the camera. Plug connections are provided at the top of the instrument, and the wires, *a b*, connect the galvanometer with the thermo-junction at the source of heat. The photographic plate is secured to its carrying slide, C, by means of little cams, and the carrier, C, is inclosed in a case, K, provided with a light-tight door, N. The case, K, is held in position by a pin, P. The connection of the photographic plate with the driving clock is shown at D. The sensitized plate moves in front of the slit, A B, and is lifted by a weight actuating a fine clock, constructed for the institution by the well known horologist, Mr. David Glasgow. It may be mentioned that the galvanometer stands on three plates, which provide the well known combination of the hole, slot, and plane for steadiness. With the aid of this instrument several hundred plates of curves have been prepared; and these, it is hoped, will be useful in the course of the investigation.

In drawing this report to a conclusion, I would thank Mr. Jenkins and Mr. Stansfield, whose assistance the institution has given me in conducting these investigations. The experiments have demanded great care, and both have worked admirably, sparing no efforts to make the results trustworthy. In Mr. Jenkins I have had the advantage, seldom to be secured in physical work, of the mechanical skill and knowledge of a trained engineer whose aid has been of much value.

General Conclusions.—It may be asked, What evidence has been gathered as to the mode of action of added elements? and does it appear that the atomic volume of the added element has a dominating influence on the mechanical properties of the mass in which it is hidden? In attempting to answer these questions, it must be remembered that in the earlier experiments pure gold was the basis of examination; and that the evidence in favor of the above view was shaken only by the somewhat abnormal behavior of aluminum and lithium, which made gold rather stronger than the volume of their atoms warranted if the theory held good. Some recent experiments† of my own, however, have shown that the relations of aluminum and gold are very peculiar, if not unique. Aluminum in solution does not behave as if its atoms were single; so that it is doubtful what the atomic volume of aluminum really is. I would also point out that, quite apart from the evidence furnished by the experiments on gold, independent testimony as to the influence of the atomic volume of an added element is afforded by Osmond's work, which shows that the presence of elements with a large atomic volume accelerates the change of β or hard iron to the α or soft variety, while elements with a small atomic volume delay the change. In the case of copper, grave complications arise from two causes. First, it is doubtful whether the copper does or does not exist in more than one state; and the passage of the metal from one state to another may be determined by the presence of an added element. Second, it is difficult to insure that a small quantity of an added element should remain unoxidized in a mass of copper—a difficulty which is of far less magnitude in the case of the experiments with gold. The true action of an added element may thus readily be masked by its action as a deoxidizer. Notwithstanding these difficulties, it is undoubtedly proved that bismuth, potassium, and tellurium—all of which have large atomic volumes—greatly lower the tenacity of copper. Arsenic, which has a larger atomic volume (15·2) than copper (7·1), confers strength on copper; but it is very certain that the limit of elasticity and the ductility of a metal are greatly influenced by the presence of such of the elements with large atomic volumes as have thus far been studied; and this fact may be of more molecular significance than the diminution of tenacity, to which, for the sake of simplicity, attention was mainly directed when the early experiments on gold were made.

The very important question now arises, May the effect of an added element mainly depend on its power of forming either a fusible or an infusible compound with the mass in which it is hidden? M. Andre le Chatelier‡ suggests that this is the case, and that the deleterious action of an element is due to its forming a fusible compound with the mass, while, on the other hand, the presence of an element which forms an infusible compound with the mass promotes the formation of a fine grain and gives strength. I would point out, however, that if this should prove to be the case, it would not remove the action of the added element from the operation of the periodic law; for there is much evidence in favor of the view that "the properties of compounds of the elements are a periodic function of their atomic weights." It must be remembered, as against the view of this skillful worker, M. Andre le Chatelier, that the whole tendency of recent work, especially that of Heycock and Neville, and my own, is to show that, when small quantities of elements are added to a metallic mass, they behave as a gas would, and remain free; and the results given in this report in the case of bismuth fully confirm this view. It remains to be seen at what point, in the cooling of a highly heated fused mass of a metal forming a solvent, an impurity would enter into combination with a portion of the mass, and what amount of impurity of a given kind has to be present in order that it may lose its individuality. If the fusibility of a free added element were the determining cause of its action, it should be possible to classify the impurities in gold in the order of their fusibility; but any such attempt breaks down hopelessly. To turn once more to the action of aluminum on gold, if a small quantity of aluminum did enter into combination with a large excess of gold, it may fairly be urged that it would tend to form the very fusible gold-aluminum alloy which contains 10 per cent. of aluminum, and not the singularly infusible one which has 22 per cent. On the other hand, the most remarkable case known of the production of a very fine-grained structure, in a mass which under ordinary conditions naturally solidifies in large crystalline planes, is presented by the action of a small quantity, ½ to 1 per cent., of tellurium on bismuth; but, as 1 per cent. is a large addition, the telluride of bismuth $BiTe_3$ is probably formed, and it is not readily fusible, for its melting point is at 360 deg. Cent. or 680 deg. Fahr.

With regard to the important molecular change which may take place in a solid metal or alloy, and of which the recalescence of steel is the most striking example, it is no small gain to have ascertained that the temperatures at which such changes occur are altered by pressure; and this seems to be a conclusion which it is safe to deduce from the experiments given in the present report.

The profound change which is produced in the properties of metals by alloying them is well shown by some recent experiments by Professors Dewar and Fleming.† They have examined the effect of very low temperatures on the electrical resistance of pure metals and alloys; and the results tend to prove that, if pure metals could be reduced to the absolute zero of temperature, they would offer no resistance to the passage of an electric current. This is true of soft, pliable metals like gold, and rigid ones such as nickel. Impure metals and alloys behave very differently; the diminution of resistance by exposure to cold is very marked, but the direction of the curves representing resistance and temperature appears to indicate that the resistance at the absolute zero of temperature would still be considerable.

I would remind the members of the institution of the nature of the work the Alloys Committee has undertaken. It is nothing less than the investigation of the fact, which has been recognized for centuries, that "traces" of elements profoundly affect the properties of masses of metals. "Traces" may either confer on metals qualities which are most precious for industrial purposes or may reduce them, through various stages of comparative unsuitability, to absolute worthlessness. It will thus be seen that the Alloys Committee is examining one of the most subtile actions in nature.

APPENDIX.

Determination of Bismuth in Copper.—In order to determine the amount of bismuth present in copper, a weighed portion of the alloy is dissolved in nitric acid, the solution is diluted with water, and heated to nearly the boiling point. An excess of ammonium carbonate is then added, until the copper, at first precipitated as carbonate, is all re-dissolved, and the solution assumes a clear blue color. It should now smell slightly of ammonia, and be kept nearly at the boiling point for from eight to twelve hours, at the end of which time the bismuth will be completely precipitated.

The precipitate is then collected on a filter, and washed by a hot dilute solution of ammonium carbonate, until it is quite free from copper salts. After careful drying and ignition, the bismuth is weighed as oxide, Bi_2O_3. The copper present in the filtrate may be determined by titration with a standard solution of hyposulphite of soda.

Copper Firebox Plate.—Analysis of a sample of copper plate taken from the side of the firebox, near the expansion bracket, on No. 49 locomotive on the Metropolitan Railway. This engine had been running for twenty years from 1870, and had covered 500,000 miles.

	Per cent.
Copper	98·7000
Silver	0·0346
Gold	0·0001
Lead	0·4085
Arsenic	0·3726
Antimony	0·0346
Bismuth	0·0360
Iron	0·0069
Nickel	0·3039
Cobalt	nil
Oxygen	0·0181
Phosphorus	nil
Sulphur	0·0064
	99·9217

BRIGHT'S DISEASE AND INSANITY.

AN able article on this subject by Dr. E. D. Bondurant is given in the April number of the *Alienist and Neurologist*, from which we take the following concluding summary:

All writers, I believe, agree as to the frequency of nephritic disease in general paresis, and our experience here is in accord with this view, every case of progressive general paresis we have had under treatment during the past twenty-two months having exhibited renal casts and albuminuria, usually, too, at an early stage of the disease. One case died in uræmic convulsions, and it is probable that the presence of the kidney lesion hastened the fatal termination in every instance. Detailed reports of cases are unnecessary.

Much has been said and written concerning the occurrence of Bright's disease among epileptics, and many observers report a high percentage of albuminuria, some going so far as to say that albumen exists in the urine of all who are subject to epileptic convulsions. Whether infinitesimal amounts of albumen can by special methods be detected in the urine of epileptics is a matter of theoretical rather than practical interest. During the period covered by this report we have had about eighty insane epileptics under care, and repeated urinary examinations have been made in all of them (Tests: heat and nitric acid; cold acid; Roberts' nitric-magnesian fluid; acetic acid—ferrocyanide of potassium; picric acid; Tanret's), with the result of discovering albumen in about forty per cent. of the cases, casts in about thirty per cent., and casts and albumen, together, in a little less than twenty per cent. of the eighty cases; in thirteen cases only may it be said that a renal weakness undoubtedly exists. Examinations of the urine immediately after the occurrence of convulsions and during the *status epilepticus* have also failed to show an especial frequency of albuminuria. In one notable instance—a white female patient, twenty-eight years old, in good bodily health—the occurrence in forty-eight hours of more than 300 convulsions was unattended by the presence of albumen, two careful analyses of the urine during the convulsions and one on the day following their cessation, bringing to light neither albumen nor renal casts.

Briefly summarizing the results of our work here, I may repeat the statement elsewhere made, that approximately one-half of the insane patients we treat exhibit a distinct kidney lesion; and this conclusion is verified by the results of *post-mortem* examination. Nearly seventy per cent. of our recent cases show casts and albuminuria. The percentage of recoveries among the non-nephritic is much greater than among those showing disease of the kidneys, though here the question of age is also to be considered, the average age of the nephritic case being greater than that of the non-nephritic. Renal disease complicates all forms of insanity, though probably the percentage is somewhat higher in melancholia. The chronic forms of nephritis are the more common, and are especially associated with depression and dementia; but we see also a large number of quite typical cases of acute Bright's disease. It is, I think, shown by many of the above cases that the mental disturbance is a symptom of the bodily weakness; in all cases an intimate connection is evident; and, almost invariably, improvement in the renal disorder is attended by distinct change for the better in mental condition.

How much more prevalent renal disease is among our insane patients than among the general population of Alabama it is impossible to positively state. There is more Bright's disease in every community than is recognized; and in general hospitals kidney disease is very common, both as a primary lesion and as a complication of other disorders.

In about sixty urinalyses in non-insane patients, however, casts and albumen together have been found in twenty per cent. only, notwithstanding the fact that the cause of the examination in many of the cases was suspected renal disorder.

It should also not be forgotten that serious Bright's disease almost invariably produces some effect upon the mental character of the patient; all physicians recognize the minor psychic symptoms of uræmia, and it should be borne in mind that, scientifically speaking, this delirium, emotional disorder, hebetude, etc., differs only in degree from a true "insanity." Not all of the nephritic psychoses are committed to insane asylums, by any means.

Edes, Tuttle, Allbutt, Spallitta and others, insist that mental disorder—especially depression and worry—cause disease of the kidneys. In a certain sense this may be true, since the influence of mind over body must necessarily be recognized. This influence, however, is very indirect; and while continued mental strain may derange the renal as well as other bodily functions, it is not to be held accountable for the frequent co-existence of nephritis and insanity—it can in too many cases be shown that the kidney lesion preceded the mental disorder. In not a few instances it seems to me probable that the nephritis and the intellectual disturbance are of approximately simulta-

* Moissan, Comptes Rendus, vol. cxv., 1892, pages 1031 and 1034.

† Proceedings of the Royal Society, 1891, vol. xlix., page 317, and 1892, vol. l., page 367.

‡ Le Genie Civil.

† Philosophical Magazine, vol. xxxiv., 1892, page 326.

neous development, and due to a common cause—the poison of an infectious disease, or a poison generated in and absorbed from the intestinal canal, for instance. It is not unlikely that some light will be thrown upon not only the pathology of the mental symptoms of uræmia, but also upon the nature of some forms of the so-called Bright's disease, by the prosecution of the study of the auto-infections, which is just beginning to receive adequate attention. It seems not improbable that many of the so-called "uræmic" symptoms may be in reality the manifestations of ptomaine poisoning, rather than a result of the toxic action of urea or the ammonium salts. The reported effects upon the animal economy of the ptomaines, muscarine, choline, neurine, etc., strikingly resemble the classic picture of some of the forms of nephritis. Instances of mental disturbance due to acute or chronic ptomaine poisoning have been reported by several recent writers.* Most poisons, including the animal alkaloids referred to, are in great part excreted by the kidneys. If these glands perform their full duty, accumulation of the deleterious matter in quantity sufficient to produce ill effects is prevented; if the poison excites disease in the kidney, or if a previously existent chronic renal lesion renders excretion imperfect, the poison, provided the source of its production remain long active, does accumulate in the circulatory fluids and ultimately makes manifest its toxic effects, mental disorder of some kind and degree being a not infrequent symptom.

Whatever interpretation be placed upon the fact of the frequent association of mental disease with kidney lesions, the practical bearing of the subject upon diagnosis, prognosis and treatment, and its consequent importance to the hospital physician, must be evident. It is to be hoped that continued work along this line in the wards of the numerous hospitals of the insane in our country may be productive of results of some permanent value in the pathology and treatment of insanity.

[NATURE.]

SCIENCE IN GERMAN MANUFACTURES.

RECENTLY, when giving evidence before the Gresham University Commission, I had occasion to speak of the attention devoted in German chemical laboratories to higher studies, and when asked what were the results of this instruction I drew attention to an article published a short time before in that most enterprising of chemical periodicals, the *Chemiker-Zeitung*, edited by Dr. Krause. In this article a description is given of the research laboratory provided to accommodate six and twenty skilled chemists, attached to the works of the Farbenfabriken, vormals F. Bayer & Co., of Elberfeld, who are manufacturers of dye-stuffs and other products derivable from tars. I told the commissioners that if, at the present time, it were desired to fit up a research laboratory for chemical purposes in London, we could not do better than take these plans and reproduce them in their entirety, and that we should then, I believed, have reason to congratulate ourselves on possessing the best appointed public research laboratory in the world.

In addition to the two dozen skilled chemists in the research department at the Elberfeld works, a large number are engaged in other departments, the total number employed being I believe over sixty.

The Elberfeld works do not stand alone; the world renowned Badische Anilin und Sodafabrik probably has in the aggregate far more laboratory accommodation than is provided even at Elberfeld. I learn from my friend Dr. Caro that of the seventy-eight chemists in the employ of this firm, fifty-six have the Ph.D. degree.

At many other works equally ample provision is made—in fact, the color works throughout Germany are simply laboratories on a very large scale.

As an antithesis, I may add that I told the Gresham commissioners that I did not think that any English color works had six skilled chemists in its employ; at all events, six was the maximum number.

Is it then surprising that, notwithstanding that a very large proportion of the coal tar used is of English origin, and that both the "aniline color" and the alizarin industry were first established here, according to a statement in the Chicago Exhibition Catalogue of the German section, about nine-tenths of the total quantity of artificial coloring matters now produced is manufactured in Germany? Whatever the proportion, in 1891 Germany exported aniline colors of the estimated value of no less than 44,269,000 marks, and alizarin valued at 12,906,000 marks—or little short of three millions sterling—a very large proportion of these manufactured coloring matters being sent to the East Indies, where they are fast displacing those of natural origin. Dr. Caro in a comprehensive monograph just published in the *Berichte*, in which the gradual development of the coal tar color industry is fully traced out, speaks of it as a German national industry. "Manufactured in Germany" is certainly now the recognized trade mark for chemicals throughout the world.

Not many years ago Wurtz wrote, with reference to the origin of the science, "La chimie est une science francaise;" at the present day we may say, without fear of contradiction, that, whatever its origin, it is now a German science; that it is to this fact that the Germans owe their supremacy, and that it is to our failure to feel the pulse of the times and to educate ourselves up to the proper point that we owe our downfall. It is to be feared, moreover, that unless we realize this without further loss of time, and hasten to fit ourselves to do our fair share of the work, other industries in which chemistry plays an important part, ere another twenty years are past, will also have quitted our shores. To do this we must put aside the idea that university extension and county council lectures, or even polytechnics and technical schools for the multitude, are to bring about the necessary reform; and we must rise above the belief that a degree given for text book knowledge and an acquaintance with the ordinary methods of analysis is evidence of competency. A true conception of what a chemist is—what he is called on to do and to know in this age of progress—must arise in high quarters and especially among our manufacturers. Our children must be properly taught at school and trained to work as well as to play, and we must cease to worry their lives at college by insisting on the study of a multiplicity of subjects, and no longer attempt to develop a Chinese system of examinations. Surely it is time that we realized that our examination system is a fraudulent failure. In Germany the victory has been gained wholly and solely through the agency of the universites—here we are still dominated by influences which had their origin in the monkish cell, and our ancient universities do nothing to help us. The intolerant individuality which has enabled us to conquer and to govern where other nations have failed is of little use in an industrial war against the most systematically instructed people in the world, whose weapons are scientific research and scientific method, and who have been careful to "organize victory," to use Huxley's expression in his remarkable letter to the *Times* at the time that the proposal to establish the Imperial Institute was under discussion. Huxley warned us six years ago of the fate that awaited our industries if we did not organize victory. I fear that so far as chemistry is concerned our insular conservatism still leads us to turn a deaf ear to all such warnings, and that the only change is that we are six years nearer to our fate.

The following particulars are mainly taken from the number of the *Chemiker-Zeitung* above referred to. I am indebted to the Farbenfabriken, vormals F. Bayer & Co., for photographs. I may add that I have had the very great pleasure of inspecting the laboratory.

The opening passage of the *Chemiker-Zeitung* notice is very significant, and is as follows:

In any industry at the present day standing still involves retrogression, and this is especially the case in the color industry, which has developed to such an extent in our country during recent years, and which owes its development in the first instance to the extreme attention paid to chemical science in Germany at the universities and technical schools. Whereas formerly, however, the color industry owed its progress almost entirely to the schools and their celebrated leaders, of late years knowledge in this great field has become so specialized that a determining influence can be exercised only by one who is within the industry. Since the color works have begun to pay attention to derivatives of coal and wood tar not only in the dyers' interest, but have also placed them at the service of medical science, and since it has been recognized that the protection afforded by a patent does not retard, but, on the contrary, promotes an industry, and is therefore to the general good, and patent laws have been introduced into Germany, of which, in comparison with those of other countries, we have reason to be proud, competition has so increased that all the works concerned are forced to make every effort to prevent their destruction in the struggle for existence. Consequently all the larger color works within recent years have erected laboratories in which a large number of disciples of chemical science are unceasingly engaged in the endeavor to meet the growing wants of the dyer by adding to the already large number of artificial coal tar colors, not only with the object of producing colors of increased beauty, but also to meet the growing desire for colors of greater fastness, and especially with the object of entirely displacing the natural dyestuffs which were formely exclusively used. These technical laboratories are necessarily arranged with special reference to the requirements of the industry, and therefore differ in many respects from the laboratories at the universities and technical schools which are used for teaching purposes.

The laboratory of the Farbenfabriken, vormals Friedr. Bayer & Co., at Elberfeld, opened toward the close of 1891, is the newest institution of its kind.

The object in view was to provide all necessary rooms for twenty-six chemists. In order to make full use of the site, however, rooms for certain other purposes were also included. The laboratory adjoins the offices of the firm and the dye house, and also the physiological laboratory. The new building is 35·66 m. long and 16·14 m. deep.

A large portion of the basement is fitted up as a store for apparatus, etc., and is connected with the laboratories above by a stairway and lift. Luxurious provision is made here for the comfort of the staff, two rooms being provided in which they can change their clothes, along one side of each of which there are twelve clothes cupboards, and a bench with cupboards for boots underneath extending along the opposite side; and also of twelve separate bath rooms with hot and cold water, and a lavatory with twenty-four basins. The heating apparatus for the baths, and a low pressure steam heating apparatus, are placed next to the wall at one end of the building, and here also niches are constructed for autoclaves—*i. e.*, vessels in which materials can be heated under pressure.

The ground floor is 6 m. high from floor to floor, excepting at the eastern end, where it is 1·28 m. deeper. The eastern higher portion is divided by a floor into two low apartments fitted up for experimental dyeing. Next to this and beyond the stairway on either side of a corridor are two rooms, 2·96 × 5·61 m., one of which is a combustion room, the other containing balances and other physical apparatus. The whole of the remaining space, 24·18 m. long by 14·6 m. deep, is fitted up as a laboratory for twelve chemists, and comprises twelve separate working places, and two for large operations for common use. This arrangement has the advantage that each chemist has had placed at his disposal a separate laboratory for his own use without the room having been deprived of its uniform character.

The first floor includes a room 8·13 m. by 3·21 m. for the use of the director of the laboratory; a room 9·82 m. by 5·61 m. used as a library;* a room 5·61 m. by 2·96 m. for special use; and a large laboratory corresponding to that on the ground floor with places for thirteen chemists. A gallery carried on iron brackets is constructed along the side of this room on the outside of the building, in which experiments involving the production of specially unpleasant odors can be made. This gallery is approached through a glazed doorway constructed in one of the window places, but experiments going on in it can be overlooked from the laboratory within, through the windows.

The second floor is divided into two by a partition wall, one part being occupied by the printers engaged in preparing the various labels, notices, etc., required by the firm; the other being used by the bookbinders who make up sample books, etc.

The attics are used as store rooms.

The building is simply constructed of brick, stone being used only for the window sills; in fact, it is characterized throughout by simplicity and solidity of construction. The basement floor is cemented; the remaining floors are covered with antilaeolith, a clay asphalt which withstands hot strongly acid liquids.

The drainage water is carried away in open channels constructed in the floor.

The electric light is used throughout, the large laboratories being each illuminated by means of four arc lamps and the other rooms by glow lamps.

It has not been thought necessary to introduce any mechanical system to secure general ventilation. Air is admitted through openings in the upper part of the windows, the foul air finding sufficient means of escape up a shaft in which there is a spiral staircase, at the end of the large laboratories, and which terminates in a large opening in the western gable. Special care, however, is taken to remove fumes evolved in the chemical experiments. For this purpose a large number of earthenware pipes, 15 c. cm. in diameter, are built into the walls between the windows in the large laboratories and elsewhere; these are carried up and connected with asphalted flues, which eventually terminate in a large air shaft carried out above the roof; the necessary draught is secured by means of a large fan placed at the base of the shaft and driven by the engine in the printing department. At right angles to the walls at both sides of the rooms, between the windows, hollow walls are built out about 2·5 m., on either side of which draught closets are constructed, flue pipes such as have been referred to being let into these walls.

Passing over numerous interesting details of construction, the arrangement of the laboratories may now be referred to. Each place is so arranged as to constitute a complete laboratory with every necessary provision, while at the same time there is nothing to prevent the various chemists working together, or to hinder the general supervision of the laboratory. The two side benches are connected by the window bench, so that each chemist has command of a bench about 15 m. long! The bottles on the shelves of each place contain 180 different agents—among these being all the substances in use or produced in the works, so that, if desired, any combinations tried in the laboratory may at once be effected on the large scale in the works. The pipes for gas, water, compressed air and vacuum are carried in a space behind the shelving, and can be easily got at for repairs, the shelving being made removable. The benches, except at the windows, are covered with lead. Under the bench there are numerous drawers and cupboards, containing all apparatus that can possibly be required, and also chemicals, such as salt, potassium chloride, sodium acetate, etc., which are used in large quantities. A sliding stand projects from a cupboard on the right-hand side, carrying measuring cylinders inverted over pegs. Each drawer or cupboard, in fact, has its special purpose, and is carefully labeled, the same arrangement being maintained throughout the laboratory, so that the attendants are able to see that each chemist is supplied with all necessary apparatus. On either bench next the window there is a closed draught closet, and next to it a hood, it being possible to connect these by a movable window. In one of the closets there is a large copper water bath, in which steam, previously cleaned from rust, condenses and can be drawn off as boiling distilled water. This bath has the usual openings above with rings, etc., and has within it a drying oven surrounded by boiling water, a wooden drying closet being placed below in which things can be dried by heat radiated from the water bath above. The waste water and steam pass away through the hollow wall at the back of the closet, in which there is a channel communicating with the drain.

On either side of the window a pipe connected to the general ventilation system is let into the wall, to which a funnel-shaped hood can be attached, so that experiments involving the evolution of fumes can be carried on at the window bench. This bench, however, is chiefly used for titration work, and therefore shelves are affixed to the wall some distance above it on either side, on which large bottles are placed containing the standard solutions.

A sink is placed at the end of the bench on the one side, and there is a desk on the opposite side; adjoining this desk is an ice cupboard let into the bench, on the cover of which a balance for weighing out substances used in the experiments is placed. By the provision of such an ice cupboard at every place a great saving of ice has been effected: it is not only available for the storage of ice—nowadays an indispensable laboratory agent—but things can be kept cool in it even over long periods—over Sunday, for example.

Four differently colored pipes for water, gas, compressed air and vacuum run along the ceiling, and from these branch pipes are carried down the columns to the benches; taps are provided in a convenient situation, so that, if necessary, the supply of water, etc., to a bench may be at once shut off. The water pipes are covered with flannel to prevent the water, which condenses on them, from dropping down. Each working place is provided with 4 taps for compressed air, 4 vacuum taps, 11 water taps, 14 gas taps for heating purposes, and 9 gas burners in case of a failure of the electric light. A steam pipe runs along the wall, from which there are branch pipes connected with "purifiers" conveying steam to each of the large water baths before referred to, and to a valve under the hood adjoining the closet.

A shower bath depends from the ceiling at either end of each of the large laboratories for use in case of the clothes of any of the chemists or laboratory attendants catching fire.

Every bottle on the shelves is not only clearly labeled, but is also numbered, so that it is easy for the lad who has to keep the place clean and in order, however ignorant he may be, to arrange them properly, and moreover, each particular chemical occupies the same position in the row of bottles in every place in the laboratory.

* A. C. Farquharson, "Ptomaines and Other Animal Alkaloids." John Wright & Company, Bristol, 1892.
Wagner, "Physical Basis of Acute Mental Disease." *British Medical Journal*, November 7, 1891.

* Probably there are few, if any, libraries attached to educational institutions so fully provided with the current literature and works of reference as are the libraries at the chief color works.

Each chemist has a lad to assist him who washes all vessels, keeps the benches clean and the apparatus in order; in fact, does generally what he is told, even helping in the experiments. In addition, there are three lads under the supervision of an older laboratory servant in each laboratory, who at once avail themselves of any opportunity offered by the absence of the staff to "tidy up" in regions not specially committed to the charge of the young assistants. The order and cleanliness—extending even to keeping the leaden bench tops polished—thus secured is most remarkable.

Each chemist is so completely screened from his neighbor "next door," that he is not only able to work undisturbed, but practically in secret; he is only open to observation from the place on the opposite side of the main gangway, and the chemists are usually so placed that of the two working at these benches either the one is a junior under the direction of the other, or they are working in co-operation.

As a further illustration of the perfection of the arrangements, I may quote from an account before me of a visit to the laboratory a description of the steps taken to put out a fire. A crack is suddenly heard and flames and a dense cloud of smoke are seen to ascend from one of the benches; all the chemists in the room at once rush to the spot. The particular chemist is found to be unhurt, but the clothes of his laboratory boy are on fire; instantly he is dragged to the shower bath, and the fire is at once put out. Meanwhile the laboratory servant has given the alarm by means of the electric fire alarm provided in the room, and within two minutes the twelve men on duty of the twenty-four members of the works fire brigade appear in full uniform. Those present, however, by turning on all the water taps in the neighborhood of the fire and directing the water on to the burning bench, had already extinguished the flames. The room is filled with a dense black fog, but by opening the windows and a valve in the main ventilation system near the ceiling, this is very soon got rid of. The origin of the accident was simple enough: a young chemist, fresh from the university, unaccustomed to work with large quantities, had allowed his laboratory boy to heat a couple of liters of the hydrocarbon toluene, which he was using in recrystallizing a substance, in a glass flask, over a bare flame.

Another striking feature in the large laboratories is a series of brass valves arranged along the wall under a hood opposite the bench for general use; the labels under these valves bear the names oxygen, carbon dioxide, chlorine, sulphur dioxide, phosgene, methyl chloride, hydrogen and ammonia. These various gases, compressed in cylinders inclosed in cupboards in the basement, can be used at any time by communicating through a speaking tube to the man in charge of the store department, who then opens the valve on the cylinder containing the required gas, so that it only remains for the chemist to open the valve in the laboratory.

In the lower laboratory one place only is distinguished from all the others, being fitted up for electro-chemical work with the necessary current-measuring instruments, a series of about fifty glow lamps being arranged as resistances.

In the balance-room, besides balances, there is a large arc lamp with special lenses designed by Prof. Von Perger, of Vienna, used in ascertaining the effect of light on colors—in these days sunlight can no longer satisfy the needs of German industrial enterprise! Colorimeters, spectroscopes and other apparatus are also to be found in this room. Color chemists are not fond of making analyses if it be possible to characterize substances by any other means; the combustion furnaces are therefore but little used, and a number of ovens in which pressure tubes are heated have supplanted most of them.

Adjoining the research laboratories there is a "technical laboratory" full of apparatus exactly like that in use in the works, but of much smaller size. Here experiments are carried out on a somewhat larger scale than in the laboratory prior to the processes being effected on the large scale in the works; and the staff in this laboratory are also engaged in making many of the chemicals required to replenish the stores for use in the research laboratories.

The stores are in charge of two superintendents, one of whom is educated as a glass-blower. It is worth mentioning also that all thermometers, prior to their issue from the store, are there compared with a normal thermometer.

The laboratory was designed by my friend, Dr. C. Duisberg, the director, the necessary architectural assistance being afforded by Herr Bormann, architect to the works.

The foregoing is but a very imperfect account of this marvelous works research laboratory. A more typical and concrete illustration of the appreciation of the value of science by German manufacturers, however, could not possibly be found, but yet it is only one of many that might be brought forward. Personally I can only say, that while lamenting the criminal shortsightedness of my countrymen, I am lost in admiration of the enterprise displayed by their foreign competitors; it cannot be denied that they deserve to succeed.

HENRY E. ARMSTRONG.

THE VOLUMETRIC ESTIMATION OF ACETONE.—F. Robineau and G. Rollin.—(*Monit. Scient.*, vii., 272, through *Chem. Zeit*)—The usual method for the determination of acetone rests upon the conversion of that body into iodoform, which is weighed. The method is slow and inexact, owing to the loss of iodoform by volatilization. These inconveniences are remedied by the author, who converts the method into one in which the estimation is volumetric. The acetone, having been obtained in a solution free from substances that also give the iodoform reaction, is treated with excess of potassium iodide and caustic soda, and a standard solution of sodium hypochlorite run in until the conversion of the acetone into iodoform is complete, as evidenced by the appearance of a blue coloration when a drop of the liquid, being titrated, is placed on a piece of starch paper, moistened with a solution of starch and sodium bicarbonate. A mere trace of sodium hypoiodite, in the presence of caustic soda, gives a blue color with starch paper that is saturated with sodium bicarbonate. Certain precautions are necessary to obtain exact results. The liquid containing the acetone must be thoroughly alkaline with caustic soda, as otherwise more hypochlorite than the normal amount will be necessary to convert the acetone into iodoform. An excess of potassium iodide must be present. The dilution of the solution titrated must be nearly the same in all cases, and a similar strength of hypochlorite must always be used. The operation should not be conducted in a strong light, and the solution must be constantly stirred during titration. The standardization of the hypochlorite is effected by means of pure acetone.—*Analyst.*

THE GOLDEN ROSE OF VIRTUE.

IN OUR SUPPLEMENT 907 we gave an engraving from the London *Graphic* of the Golden Rose, said by our contemporary to have been presented to Madam Carnot. This is now denied, as will be seen from the following:

To the Editor of the Scientific American:

I read in S. A. S. No. 907, under the rubric, "The Golden Rose of Virtue," that it was presented (says the *Graphic*) last year to Madam Carnot. This is quite false. Neither the Pope nor M. Carnot had such a thought, I dare say. Yours faithfully,

Paris, May 30, 1893. L. BERTHIOT.

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TABLE OF CONTENTS.

PAGE

I. ARCHITECTURE.—The New Stock Exchange in Madrid.—A beautiful building recently inaugurated in the capital of Spain.—1 illustration 14590

II. ARMS OF WAR.—The Giffard Carbonic Acid Gas Gun.—A practical powderless gun of great power and accuracy.—4 illustrations 14592

III. CHEMISTRY.—The Volumetric Estimation of Acetone.—Determination of this substance by titration 14598

IV. CIVIL ENGINEERING.—The Proposed Overhead Mersey Bridge.—A high level road bridge.—Plan to cross the Mersey at Liverpool.—3 illustrations 14591

V. COLUMBIAN EXPOSITION.—An Englishman's View of Chicago and its Exhibition.—A view of a pronounced Briton of the actualities and prospects of the World's Fair 14593
At the World's Fair.—Some English notes of the great Exposition.—2 illustrations 14596
The World's Columbian Exposition.—A German artist's journey from New York to Chicago.—A favorable account of the 20 hour flier and of its journey to Chicago.—4 illustrations 14593

VI. EDUCATIONAL.—Technical Education.—By MYER BLUMENFELD.—A prize essay delivered at the Hebrew Technical Institute in this city.—A plea for technical work 14596
The Needs and Opportunities of a Great Technical College.—By Dr. S. H. THURSTON.—What is done abroad and in the United States for technical education.—An outline of what should be done for the furtherance of science 14596

VII. ELECTRICITY.—Rules for Safe Wiring.—The revised rules adopted by the National Electric Light Association.—Elaborate requirements fully stated 14598
The Telephone Patents.—By A. G. HOLCOMBE.—Concise review of the standing of the telephone monopoly 14599

VIII. MEDICINE AND HYGIENE.—Bright's Disease and Insanity.—The concluding summary of a recent article on this important subject.—Suggestive conclusions reached 14596

IX. METALLURGY.—The Effects of Alloys on the Mechanical and Physical Properties of Metals.—By Prof. W. C. ROBERTS-AUSTEN.—A recent report to the Alloys Research Committee of the British Institution of Mechanical Engineers.—A valuable and suggestive paper.—Conclusion 14600

X. HORTICULTURE.—Horticulture at the Columbian Exposition.—Notes of the present Exposition and of preceding horticultural shows, and of the gardening centers of America 14594
The Columbian Exposition.—Azaleas.—The exhibit, in Chicago, of azaleas of various kinds from all sources, with descriptions of the most interesting kinds 14594

XI. MILITARY ENGINEERING.—The Waterways of our Country and their use in Military Operations.—By W. T. HILDRUP HOUSE.—The necessity of fortifying our coasts.—The dangerous exposure to an enemy of our coast cities.—A suggestive paper 14602

XII. MISCELLANEOUS.—The Golden Rose of Virtue.—A correction as to the presentation of this emblem 14598

XIII. PHOTOGRAPHY.—Photography Without an Objective.—What can be done with pin-hole photography and possibilities of instantaneous work thereby 14600

XIV. RAILROAD ENGINEERING.—A New Car Coupling.—A French car coupling, adapted to their style of cars and buffers.—2 illustrations 14591

XV. TECHNOLOGY.—Science in German Manufactures.—How the Germans apply science in their manufacturing works.—A wonderfully elaborate application of technical skill 14597

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